MECHANICAL ENGINEERING

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Heavy-Duty Bearings with Intermittent Oscillatory Motion . . . . . R. R. Bush 911

The Road Ahead in Engineering . . . . . J. R. Van Pelt 917

Under-Car Engine-Driven Power Plants for Railroad Passenger Cars . . . . . D. R. MacLeod 921

Employee and Community Relations . . . . . H. L. R. Emmet 925

Statistical Methods and Quality Control . . . . . L. C. Young 929

Departments

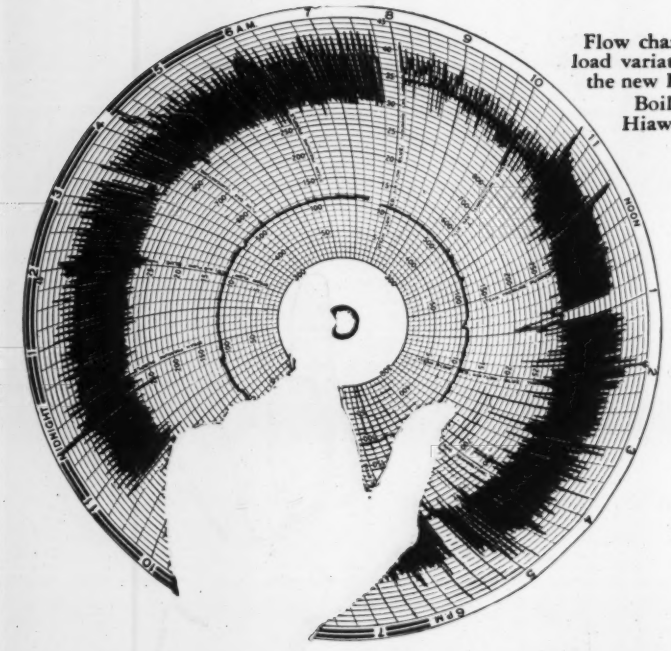
Briefing the Record, 931

ASME Technical Digest, 943

The Engineering Profession—News and Notes, 955

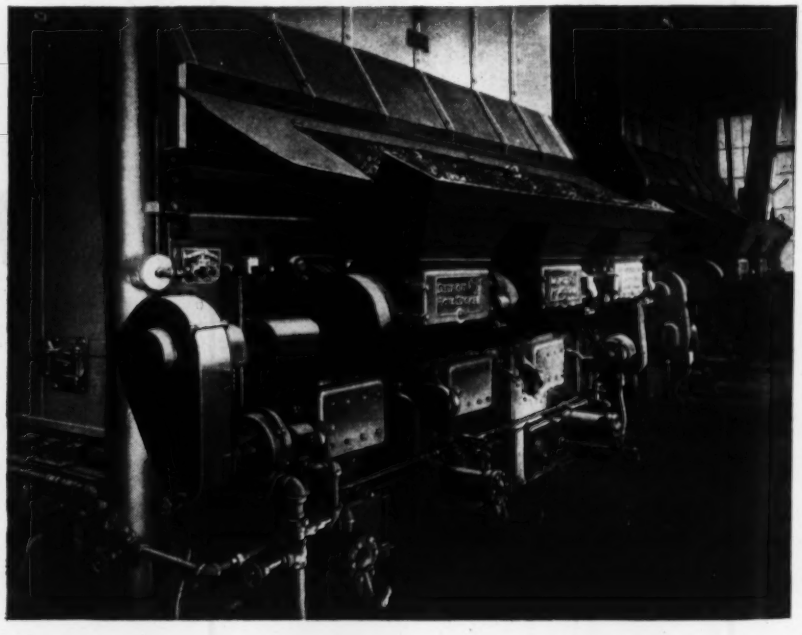
ASME News, 960

Buyer's Catalog Guide (Advertisers), 39



Flow chart shows typical load variations for one of the new Integral Furnace Boilers, Type FF, at Hiawatha Gas Plant.

Two Integral-Furnace, Type FF, Boilers arranged to burn either bituminous coal or coke breeze, mixed, or 100% of either at full load, intermittently.



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. . . with B&W Integral-Furnace Boilers at Hiawatha Gas Plant

Typical of how the B&W Integral-Furnace Boiler, Type FF, responds to quick-steaming and severe load-swing demands is the performance of two 35,000 lb. per hr. units at the Hiawatha gas-plant of the Central New York Power Corporation of Syracuse, N. Y. Each boiler successfully meets three-minute load variations of 8,000 to 12,000 pounds per hour instantaneously, up or down ... responds to the irregular quick-steaming demands characteristic of gas plant operation.

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MECHANICAL ENGINEERING

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VOLUME 71 NUMBER 11

Contents for November, 1949

RADIATION—ITS BIOLOGICAL EFFECTS AND PROBLEMS	*J. R. Martin*	893
SELECTION AND APPLICATION OF CUTTERHEADS FOR WOOD	*K. W. Duff*	899
TESTING MATERIALS AT HIGH TEMPERATURE	*F. G. Tatnall*	906
HEAVY-DUTY BEARINGS WITH INTERMITTENT OSCILLATORY MOTION	*R. R. Bush*	911
THE ROAD AHEAD IN ENGINEERING	*J. R. Van Pelt*	917
UNDER-CAR ENGINE-DRIVEN POWER PLANTS FOR RAILROAD PASSENGER CARS	*D. R. MacLeod*	921
EMPLOYEE AND COMMUNITY RELATIONS	*H. L. R. Emmet*	925
STATISTICAL METHODS AND QUALITY CONTROL	*L. C. Young*	929

EDITORIAL	891	ASME BOILER CODE	954
BRIEFING THE RECORD	931	THE ENGINEERING PROFESSION—	
ASME TECHNICAL DIGEST	943	NEWS AND NOTES	955
CONTENTS OF ASME TRANSACTIONS	950	ASME NEWS	960
REVIEWS OF BOOKS	951	ASME JUNIOR FORUM	973

BUYER'S CATALOG GUIDE	39
INDEX TO ADVERTISING PAGES	104

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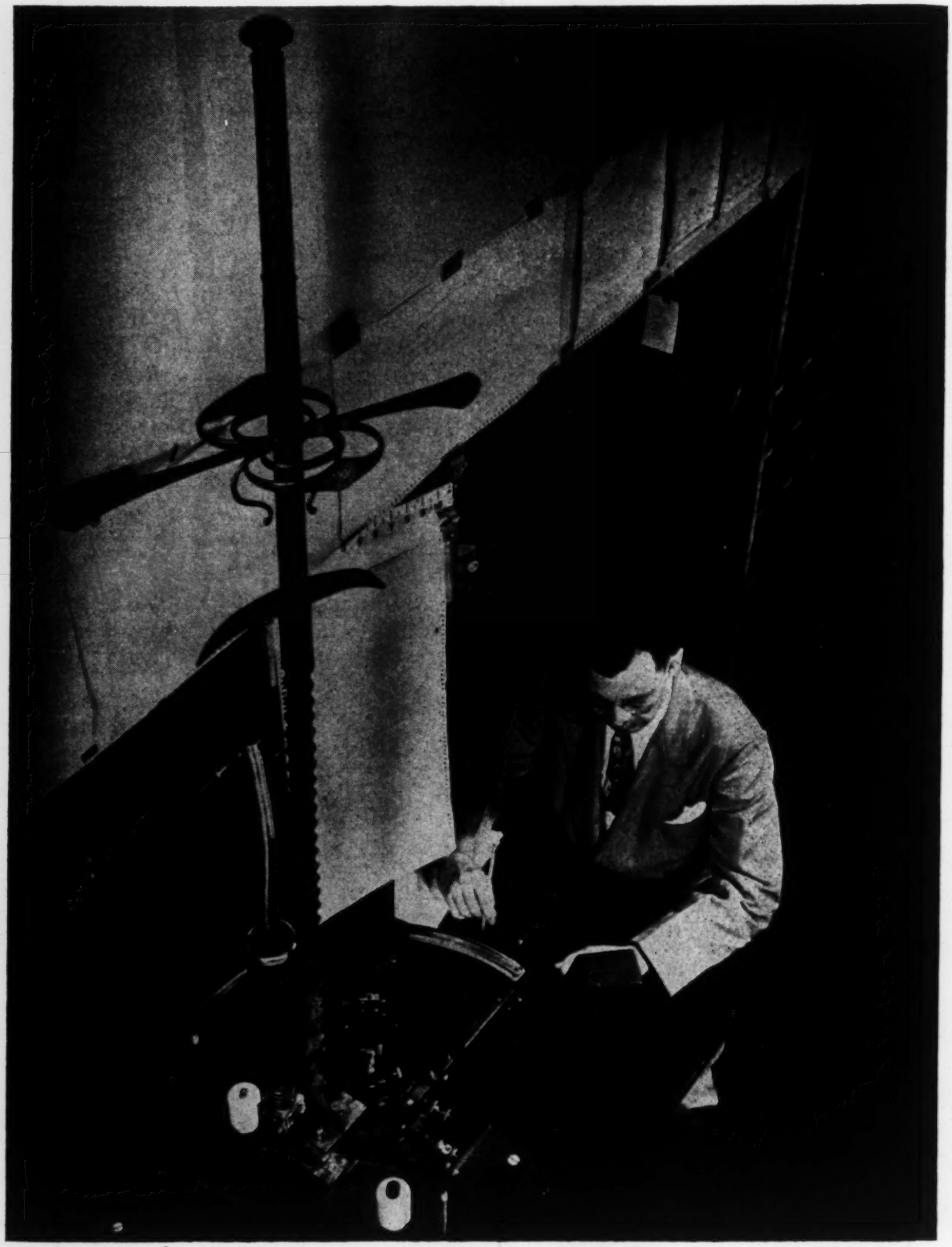

Geiger Counter Analyzing Steel Samples

(A technician at the Research Laboratory, United States Steel Corporation of Delaware, uses a Geiger counter to analyze steel forged into the blade of a medieval, two-handed sword. Powerful x rays from vertical tube at left ionize atoms of iron and alloying elements that compose the serrated blade, making them fluorescent. The Geiger counter, on quarter-circular track, identifies and measures intensity of rays. *See page 937 of this issue for further details.**)*

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No. 11

MECHANICAL ENGINEERING

NOVEMBER
1949

GEORGE A. STETSON, *Editor*

Mr. Todd at Erie

THE brief address of James M. Todd, president ASME, at a dinner in connection with the Fall Meeting of the Society held in Erie, Pa., was received with many expressions of approval and appreciation, and was in tune with the general theme which ran through the program.

"As professional men, blessed with a proper education, endowed with a mantle of leadership," he said, "we have a broad responsibility to present our views on questions of vital public interest. As citizens we all feel that our American way of life is the best way, and therefore we are interested in not only preserving it but extending it to the other peoples of the world.

"The road to continued peace in the world," he declared, "depends on the power of this nation, the strength of its defenses, and the freedom of its people. We are facing immediate problems. Some of these are new to this generation. But we have the strength, the ingenuity, to solve them. We must be strong to shake off the centralized controls which stifle initiative and put security ahead of venture."

After expressing his approval of the findings of the Hoover Commission, Mr. Todd turned his attention to the President's "Point Four."

"President Truman, in his inaugural address," he said, "called for bold steps for making our industrial progress available to underdeveloped areas. The engineers for generations . . . . have been doing that.

"Our nation has accepted the responsibility for aiding those nations who wish to help themselves. This is part of our contribution to building the road to continued peace. This is our job. We, as engineers, face it squarely.

"Increasing the productivity of nations is essentially an engineering problem. As individual engineers and through organized bodies of engineers such as ASME, the profession is aiding the work to accomplish that end.

"Through Engineers Joint Council in which ASME is working with other engineering societies (ASCE, AIME, AIEE, and AIChE) the engineering profession is doing its best to support the work of ECA. We aid in selection of personnel, in interchange of know-how with visiting delegations from foreign countries, and by visits to engineers in other countries.

"In the final analysis, however, the discharge of our individual responsibilities as citizens, as engineers, will be of greatest importance in keeping this nation and the world on the road to continued peace.

"Consider the burden under which we are working even though the ends may be justifiable. Our tax bill soared to a new high in 1948—$545,000,000,000. That represents approximately $500 per individual citizen. Three fourths of this goes to the Federal Government; state and local governments get the rest.

"Victory by bankruptcy may be the Machiavellian aim of our enemies. We as a people—industry—cannot continue to bear the ever-increasing costs. The advantages of economy in government, therefore, become increasingly important.

"If we are to remain a free people, working under the general plan of incentive for free enterprise and profit, we must have confidence in our Government. We will have confidence in our Government only if we understand—and can afford to support it."

Many a speaker has talked longer and said less than Mr. Todd.

ASME Board on Technology

AT an informal meeting of the Council of The American Society of Mechanical Engineers at Erie, Pa., in September, members of the ASME Board on Technology had an opportunity to describe the nature of their activities and to discuss some of the problems that confront them. The discussion was a fruitful one for each group. Interest shown by the Council in the work of the Board indicates the possibility that members of the Society in general may wish to know more about the Board, its functions, and its activities.

As presently constituted the Board has nine members. There are four members at large, each of whom serves for a term of four years. The appointments are so arranged that a new member at large takes his place on the Board every year. One of the members at large acts as chairman of the Board.

In addition to the four members at large there are four other members who represent four of the standing committees of the Society whose work is co-ordinated under Board procedure. These are Meetings, Professional Divisions, Publications, and Research. In general these four members are the chairmen of the committees they represent. As it is customary for a standing committee to elect as chairman its senior member, the Board has the advantage of the services of a man who bears a major share of the responsibility of that particular committee.

The ninth member of the Board is one of the directors at large of the ASME Council.

In broad terms the function of the Board is to concern itself with the technological interests of the Society. It has four major functions:

1 It co-ordinates the activities of the four committees represented on the Board. These are the committees that bear the major responsibility for the technical programs of the Society.

2 Acting under authority vested in it by the By-Laws of the Society and specifically delegated to it by the Council, the Board approves recommendations of the committees under its supervision. In addition to the four standing committees directly represented on the Board, other committees under its general supervision include the Metals Engineering Handbook Board, the Applied Mechanics Reviews Managing Committee, the Nuclear Energy Applications Committee, and the Lectureships Committee.

3 The Board formulates policies relating to the technological program of the Society.

4 It undertakes a broad study of all the fields of technology with which the Society should deal, particularly the evaluation of needs of new areas of applied science, for the purpose of initiating such projects as may be required to insure their adequate development.

It will be noted that the first three functions of the Board are administrative and involve a large proportion of routine matters. They consume a major portion of the Board's deliberations at its frequent meetings. Similarly other boards—Codes and Standards, Education, and Professional Status, Honors, Membership, and Public Affairs—operate in other areas of Society administration under authority stated in the By-Laws and specifically delegated to them by the Council.

As all these Boards report directly to the Council and operate under specific powers delegated to them annually, the Council and the Executive Committee maintain control over functions formerly performed directly by them, but are relieved of lengthy deliberations on a host of administrative matters now handled by the six boards. It is apparent that Board procedure serves to co-ordinate many related activities at the standing-committee level, that it permits adequate and thoroughly competent discussions and decisions on administrative matters, and that it affords the Council and the Executive Committee more time for consideration of broader questions of policy and procedure affecting the Society as a whole.

Some examples of the matters on which decisions are taken by the Board on Technology under the powers delegated to it by the Council should be of interest and serve to illustrate the responsibilities and duties of the Board. On recommendation of the standing committees, the Board: Approves the number and size of national meetings of the Society; approves locations and dates of national meetings and conferences of professional divisions; approves locations and dates of educational exhibits in which the Society is involved; appoints Society lecturers; establishes policies and procedures in respect to advance copies (preprints) of papers to be presented at meetings, including charges for such copies; approves the rules governing educational exhibits; approves new divisions and their scope and by-laws; approves plans for financing proceedings of professional-division conferences; makes recommendations regarding the financing of professional-division activities; establishes procedures for the distribution of Transactions; co-ordinates the responsibilities of program-making agencies and the Meetings Committee in program making; sets dead lines for receipt of papers presented at meetings; authorizes special publications, including books, translations, bibliographies, biographies, and monographs (but not codes and standards); approves research projects; and performs such other tasks as are referred to it by the Council.

Experience has demonstrated that the Board functions satisfactorily in the performance of its administrative tasks and as a means of co-ordinating the activities of the standing committees represented in its membership. The performance of these functions makes a heavy demand on the time and energy of Board members and requires frequent meetings. For practical reasons the Board must give priority to administration. Questions arising under the fourth function—study of fields of technology with which the Society should deal, questions relating to planning for the future, to the searching out of means by which improvements in procedures can be effected, and general questions relating to strengthening and raising the quality of the Society's activities in the field of technology—demand an atmosphere free from the pressure to take decisions on more routine administrative matters.

Subjects currently before the Board which require the deliberative atmosphere of long-range planning and intensive discussion include: A review of the functions and procedures of the committees under the supervision of the Board; how to improve the quality of technical papers and how to establish a scheme for the rating of technical papers; continuous review of the working of the ASME publications plan put into effect on Jan. 1, 1948; continuous effort to improve all aspects of Society preprint procedure, including distribution problems; the Society's role in and responsibility for research; policies relating to special publications of the professional divisions, such as proceedings of conferences; the financing of professional-division activities; and sound and effective procedures for selecting committee personnel.

In order to provide a proper atmosphere for the discussion of such subjects as those just mentioned, the Board has been experimenting with a supplementary type of meeting with the object of separating in time and place consideration of planning and administrative questions. Several such meetings have been held. At these meetings a discussion topic is assigned and nonmembers of the Board whose advice and opinions are desired are invited to attend. Progress to date has not been spectacular, but it is obvious that, once the Board develops this type of discussion meeting into a regular and well-organized practice, it will be able greatly to enrich the technological phases of the Society's activities.

RADIATION—ITS BIOLOGICAL EFFECTS *and* PROBLEMS

By J. R. MARTIN

DIRECTOR OF HEALTH PHYSICS, THE KELLEX CORPORATION, NEW YORK, N. Y.

INTRODUCTION

FOR billions of years since the dawn of creation there has existed upon the earth a certain background of naturally occurring radiation. This background radiation exists today and is due to the presence of cosmic rays and variable amounts of radioactive material occurring naturally. The production of large amounts of artificially radioactive substances has resulted in the accentuation of an existing phenomenon.

With the continued interest of industry in nuclear energy and its various by-products, there is a concomitant responsibility placed upon industry to maintain the excellent safety record set by the Manhattan Project and the Atomic Energy Commission. The combined research of engineers, physicists, biologists, and radiologists developed maximum permissible exposure limits and tolerance concentrations of radioactive isotopes in water and air.

A cursory examination of the procedures required to insure safe handling of radioactive material is apt to be discouraging. However, the interpretation of these rules in terms of actual protective and measuring devices coupled with the consideration of the biological effects of ionizing radiation will remove in part the artificial veil of mystery and apprehension which surrounds this subject.

BIOLOGICAL PHASE

Cell Description and Normal Cell Processes. In the reaction between ionizing radiation and living tissue, the unit of the biological component is the cell. The cell is composed of protoplasm and is divided into an inner compact nucleus and a surrounding fluid layer. The nucleus is the principal part of the cell. It contains the nucleo-protein which in the process of cell division forms threadlike structures known as chromosomes. The chromosomes in the germ cells provide the mechanism of heredity. Generally speaking, heredity is the appearance of qualities in the offspring tending to produce a resemblance to its ancestors. The chromosomes in turn are made up of building blocks called genes, which contain the factors that determine the specific qualities of the cell and offspring. The genes determine body proportions, size, skin color, hair color, and certain mental traits and capacities, as well as susceptibility to defects and diseases. All these characteristics are known to be inheritable.

In the union of the male and female germ cells, one half of the chromosomes are contributed by the sperm and one half come from the ovum. All organisms are produced from a single cell, the ovum. The union of the male and female cells is known as fertilization. Following fertilization, a rapid division of cells takes place. The division is elaborate and follows a definite pattern, Fig. 1.

The nuclear material condenses to form long threads. The nuclear membrane disappears. The threads become loaded with disoxyribose nucleic acid and form thick rods, the chromosomes. At metaphase the chromosomes become oriented in the equatorial plane of the cell and split longitudinally. Apparently under the influence of the centromere, a catalystlike body which fortuitously appears, the two halves of each chromosome separate and move to opposite poles. The nuclear membrane reforms, the chromosomes become indistinct, and the cell divides. The two daughter cells have the same number of chromosomes as the parent.

From the single-cell origin, a phenomenally large number of cells are formed. There follows, with growth, a differentiation into three primary layers. The layers further differentiate into aggregations of similar cells to form tissues. To perform functions, the tissues further organize into organs. The ultimate in this process of maturation is an organism capable of a multiplicity of functions. In cells of different tissue the nuclei are similar, but the surrounding fluid media or cytoplasm is different. The cytoplasm takes on a form best suited to its function—fibers for connective tissue, contractile bands for muscles.

In the process of life, there is a continuous destruction and replacement of cells within the body. Having reached maturity, cell division levels off, and a balance of cellular death and replacement occurs.

A sketch depicting the arrangement of cells in the skin may serve to illustrate the interrelation of cells in an organized tissue. Since the function of the skin is protection, certain specializations of cells may be noted, Fig. 2.

The corium or derma is the underlying supportive layer composed of connective tissue containing blood vessels, capillaries, and nerves. The stratum germinativum is the reproductive layer. The layers from the stratum germinativum out is the epidermis.

The columnar-shaped cells divide and force the daughter cell toward the periphery into the strata mucosum and granulosum. In this layer, cell division occurs, but at a reduced rate. The cuboidal-shaped cells of this layer are compressed gradually and pushed to the surface. The nuclei become dense, and the cells lose their power of reproduction. Indeed, they may be considered half dead and half living. Finally the cells become indistinct and form a nonliving layer at the surface, the stratum corneum. The most superficial part of this layer is little more than horn scales. The stratum corneum is thickest on the palms of the hand and the soles of the feet. The stratum lucidum or clear area, probably occurs only at these sites.

When the epidermis is wounded, a blood clot fills the defect, and the cells grow from the stratum germinativum to fill the gap. When the defect is too great, it is repaired by fibrous tissue growing from the bottom of the wound. The epidermal edges are too far apart to span the surface and grafts of epidermis are required.

When an abnormally greater number of cells are destroyed as the result of an adverse environment, the reparative processes are stimulated, and necessary cell division proceeds at an increased rate. Abnormal demands on the functions of tissue

Contributed by the Nuclear Energy Application Committee and presented at the Spring Meeting, New London, Conn., May 2–4, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

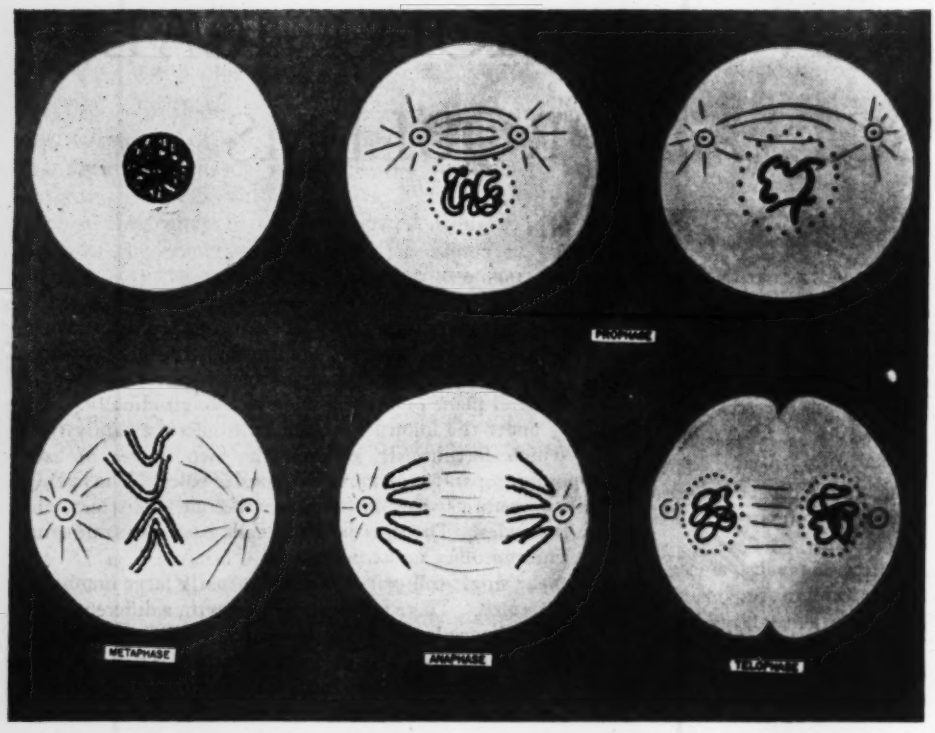


FIG. 1 CELL-DIVISION DIAGRAMMATIC

act as stimuli to growth. Witness the muscle of the athlete. The white blood cells increase in the presence of infection and, having engulfed the offending invader, they decrease to a normal value.

Radiation Effects on Normal Cell Processes: Immediate Reactions. The passage of ionizing radiation through the living cell results in interference with the biochemical reactions which determine the reaction of the cell to its environment. Damage to the reproductive apparatus of the living cell produces changes in the ability of the daughter cells to survive and multiply.

The continuation of life depends upon the ability of the cells to provide for normal replacement and to provide for replacement in the face of abnormal demands and adverse environment. The action of ionizing radiation and living tissue interferes with cellular division. Massive acute doses of ionizing radiation, in terms of thousands of roentgen units delivered to the tissues, produce chemical changes within the cell and produce lethal effects in a manner not commonly encountered and not within the scope of this paper.

Radiation in amounts not sufficient to produce unfavorable chemical reactions, are able to cause the death of the cell at the following nuclear division, or produce such an unfavorable genetic balance that death occurs after a series of divisions. One or two ionizations within a chromosome can break the rod and destroy or eject a gene at the point of rupture. With restitution of the break, cell division will continue, and the successive daughter cells may be normal or abnormal depending on the importance of the gene removed from process. In the apparently normal daughter cells, the absence of the gene may be manifested much later after numerous divisions. If restitution does not occur, or if multiple breaks occur and the fragments interchange during restitution, the effect will be more serious and death of the cell probably will occur at following cellular division. There are intermediate effects between these two extremes depending on geometrical configurations assumed by the injured chromosome.

With this relationship in mind and recalling the arrangement of the cells in the skin, it may be seen that radiation damage to the layers superficial to the basal layer of the epidermis is relatively unimportant. Even sporadic destruction of the cells of the basal layer will be replaced by the adjacent cells. However, widespread damage to the reproductive layer, as well as to the underlying tissue, produces serious wounds or burns.

A similar situation presents itself in the formation of blood

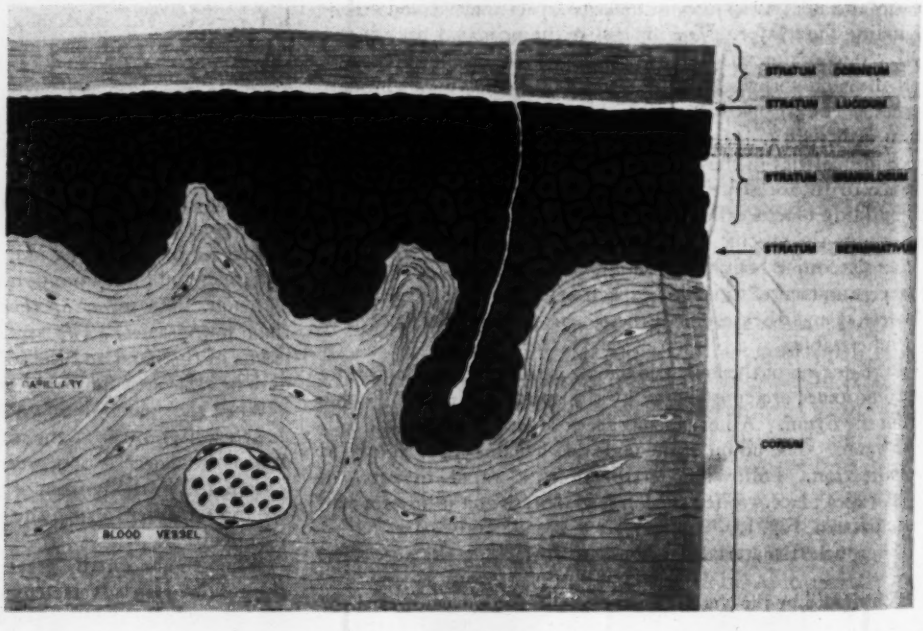


FIG. 2 SKIN DIAGRAMMATIC

cells. Red blood corpuscles and certain white blood cells are formed from mother cells in the marrow of flat bones. The mature cells leave the marrow cavities and circulate in the blood stream. Formation of the replacement cells takes place almost exclusively in the marrow. When the circulating blood cells are destroyed or exhausted, it is a temporary loss. Damage to the mother cells is more serious and irreversible anemias will result. When the body no longer can respond to infection by the production of an adequate number of white blood cells, the infection becomes overwhelming.

Since the centers of blood formation are widespread in the body, serious depletion of the blood cells by externally applied radiation requires a dose over the whole body or a good proportion of it. Deposition of long-lived radioactive isotopes in the bone will affect the mother cells adversely. All degrees of destruction can be visualized in biological systems influenced by ionizing radiation. Biological effects of the magnitude here described are acute in onset and begin to manifest themselves in the neighborhood of about 100 r (roentgen units). The acute lethal dose is stated to be in the neighborhood of 600 to 800 r. If the dose is smaller and the chromosome damage is not severe, and produces only mild genetic unbalance, the skin- and blood-forming tissue will show their adverse changes years later.

The variable factors are principally (1) the biological significance of cells being acted upon; (2) the number of cells affected; (3) the severity of chromosome damage; and (4) the density of the ionization path.

Long-Term Effects. Heretofore, we have dealt with the mechanism of radiation to cells of an existing organism which is exposed to radiation. When considering the effects upon future generations, the mode of action is analogous to that discussed for cells as a component of a tissue. When germ-cell division is prevented, sterility results. When genic and chromosome variations are produced in the germ cells of both parents, mutations or changes in the qualities of the offspring appear according to fairly definite laws. The mutations which result from radiation injury are those which are occurring normally in the general population and will not produce a bizarre new individual. In short, radiation injury under these special conditions may increase the frequency rate of a normally occurring phenomenon.

There is a natural background of ionizing radiation which amounts to 2.5×10^{-8} r per sec or a total of about 50 roentgen units per 65 years of life. The importance of this amount of radiation on the human race since the dawn of life has not been determined. The natural background is not of the magnitude which, on the basis of present knowledge, could account for the normal mutation frequency. Although the natural background of 2.5×10^{-8} r per sec will not account for the mutation rate, it is a contributing factor.

A composite analysis of all pertinent data from biological experimentation has prompted the Advisory Committee on X-Ray and Radium Protection to recommend a tolerance dose of 0.3 r per week for gamma and x rays. To extend this tolerance dose for other ionizing rays, the value will remain the same, but the unit will change to "roentgen equivalent man" (rem). The balance of cellular destruction and replacement will not be disturbed by this amount of radiation. There is a certain reciprocity between the rate of receiving the dose and time. There appears to be little difference if the daily fraction of the weekly dose (60 mr per day) were received in 1 min or received over an 8-hr working day. At very high intensities this reciprocity is no longer valid.

RADIATION CHARACTERISTICS

Types of Radiation. In any discussions of the health aspects of radiation it becomes necessary to consider the nature of ionizing radiation and its interaction with matter, as well as the nature of living cells, their interrelationships in forming the complex organisms, and their physiological response to changes in their environment.

Proton. Although the more familiar types of ionizing radiations are alpha, beta, gamma, and x rays, in considering the nature of ionizing radiation, it is convenient to begin with another, the proton. The proton is the nucleus of the hydrogen atom having a positive charge equal and opposite to that of the electron. It has a mass of 1.66×10^{-24} g and an atomic weight of approximately 1.

Neutron. The neutron is a particle of approximately equal mass of the proton but without an electrical charge. The neutron does not ionize of itself, but transfers its energy to protons and atoms of low atomic mass, which in turn recoil with the production of a dense ionization track. Because of the absence of a charge, the neutron is capable of penetrating the nucleus of atoms in its path and so altering the energy state of the nucleus that it tends to revert to its normal state by emitting various ionizing rays (alpha, beta, or gamma).

Alpha Particle. The proton and neutron compose the nucleus of atoms and occur in various combinations according to definite patterns. The alpha particle is the helium nucleus and contains two protons and two neutrons. Its mass is approximately 4 times that of the proton or hydrogen nucleus and, because of the presence of two protons, has a positive charge twice that of a single proton. The relatively greater mass of the alpha particle and its relatively greater charge produce very dense ionization tracks in matter through which it traverses.

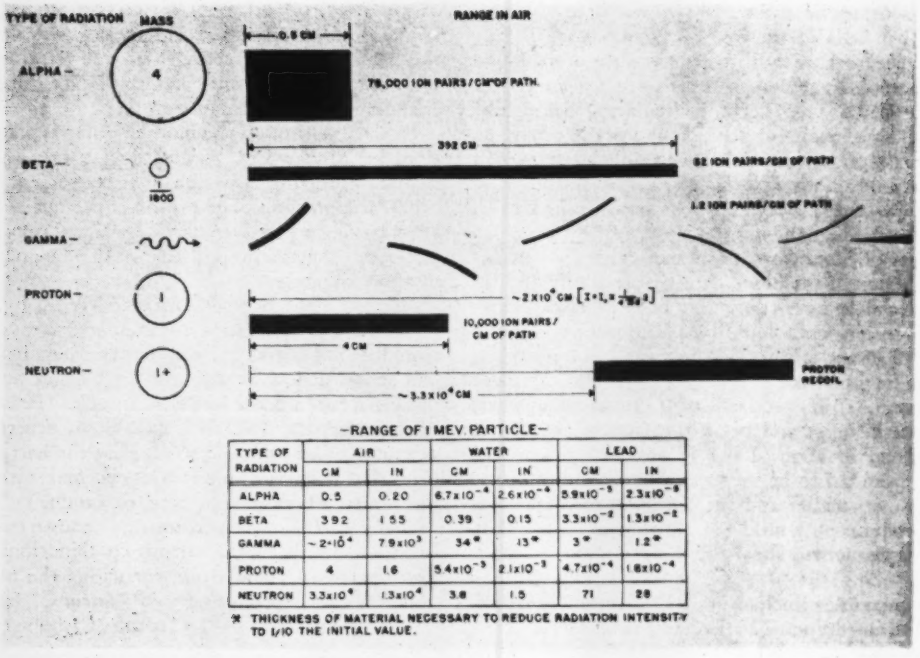
Beta Particles. The smallest particle capable of producing ionization is the electron which has a mass approximately 1/1836 of the proton or 9×10^{-28} g. The electron bears a charge designated as negative and equal in magnitude to that of the proton, being in the order of 4.8×10^{10} esu (electrostatic units).

Because of the relatively small mass of the electron its ionization track is light in comparison to alpha particles and protons. It is easily deflected when passing through matter, and the track tends to be very irregular. The electron is the extranuclear component of the atom and, in the classical concept of the atom, electrons travel in orbits about the nucleus. The total number of electrons in the various orbits is equal to the number of protons in the nucleus. This normal balance results in an electrically neutral atom. Removal of one or more electrons from the orbital component converts the atom into an ion of a positive charge. The atom has been likened to a very minute solar system with the diameter of the entire atom approximately 10^{-8} cm. This is a hundred thousand times the nuclear diameter of 10^{-13} cm. Beta rays are fast electrons ejected from radioactive material. Cathode rays are artificially accelerated electrons.

X Rays and Gamma Rays. X rays and gamma rays are electromagnetic waves emitted in definite bundles or quanta. The wave length of x rays is in the range of 0.05 to 10 angstrom, that of gamma rays is in the range of 0.001 to 0.1 angstrom. They are very similar to each other and react with matter in much the same way. The quantum energies of x rays are correspondingly lower than those of gamma rays, the former being in the order of 0.2 Mev (million electron volts) for a 200-kv tube voltage. The energy of gamma rays may range up to 10 Mev.

The range of gamma rays in air is a function of its energy and is considerable in comparison to alpha or beta rays. For a 1-Mev gamma ray, the range is about 20,000 cm.

The absorption of gamma ray occurs through three principal mechanisms as follows:



–RANGE OF 1 MEV PARTICLE–

TYPE OF RADIATION	AIR		WATER		LEAD	
	CM	IN	CM	IN	CM	IN
ALPHA	0.5	0.20	6.7×10^{-4}	2.6×10^{-4}	5.9×10^{-5}	2.3×10^{-5}
BETA	392	155	0.39	0.15	3.3×10^{-2}	1.3×10^{-2}
GAMMA	$\sim2\times10^{4}$	7.9×10^{3}	34*	13*	3*	1.2*
PROTON	4	1.6	5.4×10^{-3}	2.1×10^{-3}	4.7×10^{-4}	1.8×10^{-4}
NEUTRON	3.3×10^{6}	1.3×10^{6}	3.8	1.5	71	28

* THICKNESS OF MATERIAL NECESSARY TO REDUCE RADIATION INTENSITY TO 1/10 THE INITIAL VALUE.

FIG. 3 TYPE OF RADIATION—RANGE AND ION DENSITY CHART

1 The photoelectric effect wherein the energy of a quantum is absorbed completely and an electron is ejected from the absorbing atom. The photoelectron leaving the atom acquires the energy of the absorbed quantum less the binding energy which was required to detach it. The photoelectric effect occurs in the lower energy ranges of the incident gamma rays.

2 The production of recoil electrons and the scattering of the quantum of gamma radiation which continues with reduced energy to react with other atoms, Fig. 3.

3 High-energy photons in the vicinity of a nucleus will give rise to a pair of electrons, one of which differs from the usual concept in that it bears a positive charge. The electron and the positively charged electron, the positron, recombine with the formation of two photons of gamma radiation with energies approximately one half that of the original photon.

UNITS OF RADIATION MEASUREMENT

Roentgen. The ability of x rays and gamma rays to penetrate the body places them in the category of external hazards. Their absorption depends upon the atomic number of the absorbing medium, and it is convenient to measure the energy absorbed in a given volume. Since air becomes conducting under the influence of ionizing radiations, the current through a cubic centimeter of air is a measure of energy absorption. The roentgen is defined as that quantity of x or gamma radiation such that the associated corpuscular emission per 0.001293 g of air, produces in air ions carrying 1 electrostatic unit of quantity of electricity of either sign. It is equal to the liberation of 2.08 times 10^9 ion pairs per cu cm of air and corresponds to the dissipation of energy to the extent of 83 ergs per g of air.

Roentgen Equivalent Physical. The definition has been further extended to include any ionizing radiation, such that the amount of radiation which produces an energy absorption of 83 ergs per g is one rep (roentgen equivalent physical).

Roentgen Equivalent Man. The selection of the unit rem (roentgen equivalent man) indicates that, for a given energy absorption, the biological effect is dependent upon the character of the radiation. The rem is that dose of ionizing radiation which produces a biological effect equal to that produced by 1 roentgen of high-voltage x ray.

RANGE AND RELATIVE BIOLOGICAL DAMAGE

Protons and neutrons are 4 times more effective in producing biological damage than are beta and gamma rays. Alpha particles are about 10 times more effective than beta or gamma rays.

The specific ionization along the tracks of the rays appears to be the determining factor in biological damage. For alpha, beta, gamma, and neutron rays, the ionization produced for rays of equal energy is shown graphically in Fig. 3. The range in air is compared to the range in water and lead. If isotopes emitting any or all of these rays were introduced in the body, the effects would be proportional to the density of their ionization tracks. Because of their limited range, alpha and beta rays of moderate energy would not be able to penetrate to any great extent into the skin of the animal. However, skin is an important living tissue and its destruction can be very incapacitating. The greater range of x rays, gamma rays, and neutrons permits them to penetrate the skin and underlying tissues and need not be introduced into the body tissues by eating, drinking, inhalation, or contamination of wounds to exert their effects. The sense perceptors of man are incapable of detecting, unaided, the presence of these rays.

RADIATION PROBLEMS

Hazards to Be Overcome. There exist two modes of action for ionizing radiation to affect an organism: (1) The action of externally applied radiation from penetrating rays; (2) the fixation of radioactive isotopes within the body where the nonpenetrating rays also may exert a deleterious influence.

External Hazards. Recalling the range of representative alpha and beta particles, it can be seen that they are not capable of effective penetration into the body. Gamma and x rays are capable of passing through the body, and those rays

which dissipate their energy within the body tissues exert an effect.

Internal Hazards. A more subtle hazard exists in the deposition of radioactive isotopes within the body. Radioactive particles or gases in the air may be inhaled. Contaminated food and water gain access to the body through the digestive tract. Puncture wounds by contaminated instruments or contamination of clean wounds by radioactive substances may result in the deposition of long-lived radioactive particles under the skin. The respiratory tract is fairly efficient in preventing the entrance into the lungs of particles greater than 10 microns. The fate of the particles which enter the lungs is determined by their solubility. Insoluble particles remain in the air spaces of the lungs and deliver their radioactive dose to the sensitive lung tissue. Soluble particles are taken up by the blood stream and transported to other parts of the body. A portion of the absorbed material is excreted immediately, while the remainder is deposited in the tissues to be eliminated slowly.

The radioactive substances, which inadvertently may be eaten by ingestion of contaminated food and water, or carried to the mouth by contaminated hands, may be absorbed into the body tissues when they are soluble in the digestive juices. The fate of such substances is similar to that of the inhaled particles. The sites of deposition within the body are uniform for specific isotopes, but vary for different elements, depending on the metabolic processes of the organism.

Calcium is a normal constituent of bone, and radioactive isotopes of calcium and related elements are deposited in the bone. Iron is utilized in the red blood corpuscles, and its isotopes follow the same pathways. Iodine is normally taken up by the thyroid; radioactive iodine is metabolized in the same fashion. Heavy metals, although not a normal requirement of the body, deposit themselves within the bone. Unfortunately, a great number of radioactive isotopes fix themselves in the bone substance and are very slowly eliminated. Plutonium is deposited selectively on the vital inner lining of the bone wall and is in position to deliver its radiation to the bone-marrow cavity and blood-forming tissues.

The time required for a radioactive substance to decay to one half its original amount is known as the "half-life." Similarly, the time required for the body to eliminate one half of a radioactive substance is designated as the "biological half-life." Deposited radioactive isotopes with long biological half-lives are irradiating the tissues 24 hr a day, as opposed to externally applied radiation, which is operative for intermittent periods up to 8 hr a day.

FIG. 4 CHEMIST WITH POCKET CHAMBERS AND FILM BADGE, INDICATING PROTECTIVE CLOTHING

Precautionary Measures:

Shielding and Time. The introduction of dense materials of high atomic number, such as lead, is effective in reducing the range of gamma and x rays. Less dense materials, such as concrete, are equally effective when used in thicker layers. Since air absorbs radiation, distance is also a protective factor. Handling tools may permit manipulations and prevent an above-tolerance dose being recieved by the operator.

Time may be substituted for shielding and distance, when the radiation flux is not too great, that is, to circumvent the reception of above-tolerance doses, the time of exposure may be reduced. If a procedure is to be conducted in an area where the intensity is such as to produce an absorption of 4 roentgens, a man may be permitted to remain 1 min. A number of individuals, each charged with the responsibility of performing a single manipulation, such as turning a valve, or adding a reagent, may be lined up in such a fashion as to perform a series of maneuvers to complete the experiment.

In practice, pilot-scale operations are preceded by laboratory investigations employing tracer or minute quantities of radioactive materials. On the basis of laboratory work, the shielding requirements for plant construction are anticipated.

The construction of heavy shields of lead, concrete, or steel has necessitated the design of remote operational devices, and a whole galaxy of equipment which, although passed over with a few sentences, permits the safe operability of various processes and experimental procedures.

Protective Clothing. In the laboratory building, uniforms consisting of issued shirts, pants, and shoes are worn by the chemists. In the rooms in which radioactive material is being processed, a laboratory coat is worn and is not removed from the room, to prevent the spread of contamination throughout the building. Uniforms are laundered on the premises, and the laundry water monitored for activity before discharge to the sewer system.

Rubber gloves of the surgical type are worn when contamination of the hands is anticipated. Frequent hand washing and monitoring with GM tubes prevents inoculation of food and prevents contamination from reaching the mouth.

Monitoring. The protective measures undertaken for externally applied radiation have been noted previously as shielding, time, and distance. In addition, personnel are monitored by pocket ionization chambers and x-ray film badges, Fig. 4, which record the amount of external radiation received by the individual. The pocket chambers are calibrated in milliroentgens and are read daily. The film badges are interpreted in terms of milliroentgens by comparing the degrees of film darkening with standards in a densitometer. The film-badge and pocket-chamber readings are recorded to form a permanent tabulation of the total exposure of the worker to external radiation.

Air contamination is controlled by rigid adherence to operating rules requiring the use of hoods for heating and evaporating radioactive solutions. Radioactive chemicals are not handled in a dry state, except in a closed system. Spills are cleaned immediately. Hood ventilation is checked frequently, and an adequate flow maintained across the hood face.

Collection of all active waste solution in special containers and collection of rinse solutions which may be contaminated, prevent discharge of radioactive material to the sewers.

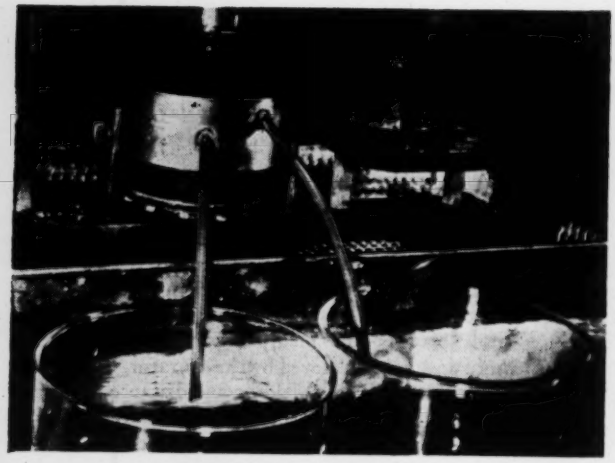


FIG. 5 PROCESS MODEL

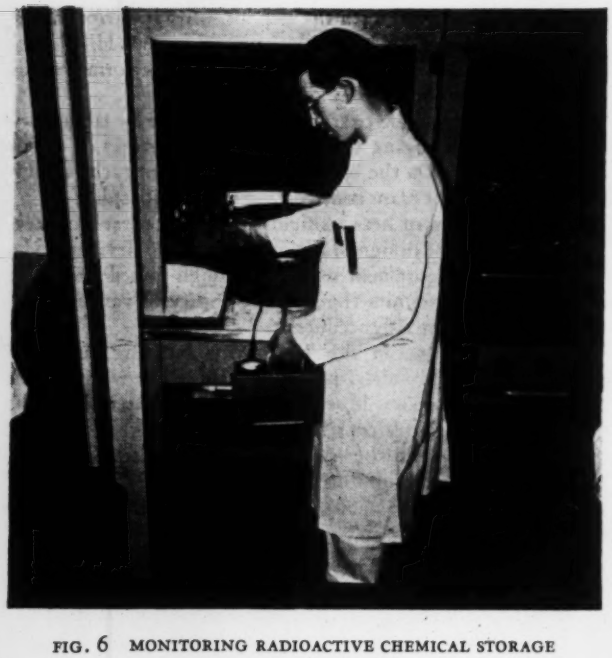


FIG. 6 MONITORING RADIOACTIVE CHEMICAL STORAGE

The surrounding area is monitored periodically or continuously, depending upon the levels of radioactivity of laboratory or plant work, to insure the efficiency of the air-filtering processes of the effluent of the hood system. The sanitary drain effluent is spot-checked to prevent an increase in its background radiation level. Figs. 5 to 8, inclusive, show various safety measures applied in the radiation laboratory.

CONCLUSION

Tolerance concentrations of radioactive isotopes in air to produce an average tolerance dose to the affected organ at the end of 1 year are in the order of a millionth of a microgram per cubic centimeter of inspired air for certain alpha emitters. For beta emitters of long half-life, the amounts which must be detected are minute, ranging from a thousandth to a hundred thousandth of a microgram. Ionization chambers and Geiger-Mueller tubes are capable of measuring these very minute quantities.

The protective measures undertaken to insure safe handling of materials in the field of nuclear energy are similar to those in force in industries employing toxic chemicals. Improvements or modifications of existing methods, or the development of new principles for the protection of individuals and the general population present a continuous challenge to engineers, physicists, and biologists. The success of the whole program depends on the ability of detection instruments to note the presence of a hazard and indicate its magnitude.

FIG. 7 LABORATORY SHIELDING WITH SAMPLING DEVICE

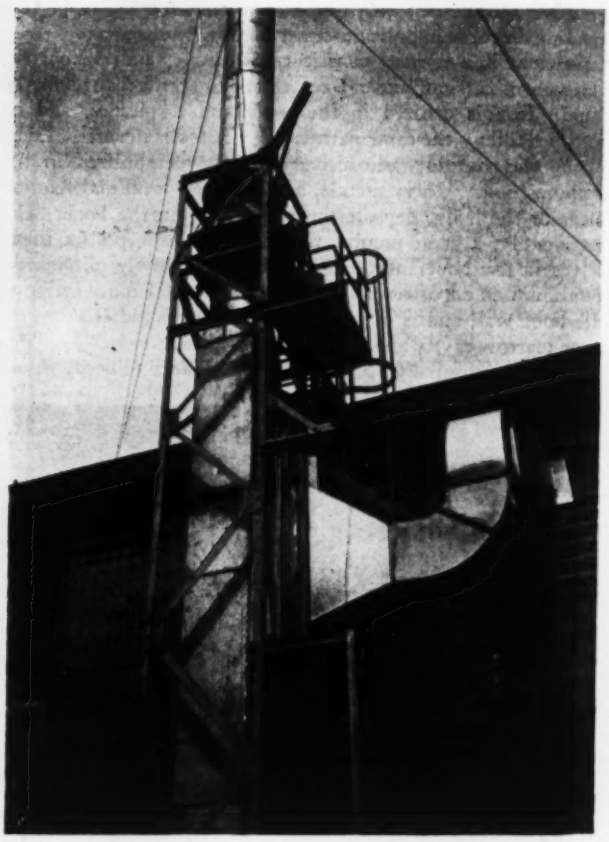


FIG. 8 HOOD VENTILATION STACK AND FILTER CHANGER

SELECTION *and* APPLICATION *of* CUTTERHEADS *for* WOOD

By KENNETH W. DUFF

HENRY DISSTON & SONS, INC., SEATTLE, WASH.

IN finishing sawed lumber, the primary consideration is to obtain maximum quality of finish commensurate with economical costs. Most often this is done by the use of cutterheads in planers, molders, surfacers, etc. Depending upon the end use of the product being machined, the quality of finish can vary greatly. Finish that is commonly used in the box-board industry might not be acceptable in the furniture industry. The degree of finish required has considerable bearing upon the selection of the cutterhead used. The finer the finish the more accurate must be the selection. With proper cutterhead and knives, it is possible to produce work that is comparable to sanded finishes in many cases. To produce work of this quality the stock must be uniform, the machine in near-perfect condition, and the cutterhead at its highest cutting efficiency. Defects in planing can be eliminated largely by use of the proper cutterhead. These defects and their remedies will be discussed later.

CUTTING ANGLES

The type of wood, the degree of dryness, and the method of drying affect the cutterhead that should be used. Fig. 1 shows the four variables of a straight knife which affect its cutting action. These same terms also apply to milled-to-pattern knives and circular bits. The factor that most often is changed with a change of species is cutting angle. Many published charts recommend cutting angles for various common woods. These charts give a range of cutting angles for each species, the cutting angle increasing as one goes from dry to green stock. Such charts are valuable in many instances; but it will be found that a cutting angle of approximately 15 deg is listed for most species of wood somewhere in the range from green to dry. These charts are at best rough guides to the selection of the proper cutting angle.

The woodworking industry has been criticized in the past for failure to determine proper feeds, speeds, and cutting angles for various species of wood (1).[1] With the wide variety of machining characteristics found in different lots of the same species, in fact, often in a single tree, it is practically impossible to set up one correct cutting angle for a particular wood. With some types of woods this variation is great; while in others, principally softwoods, wood of a particular species from a given area will run very uniform. Tests (2, 3) have shown that for eastern hardwoods, cutting angles of 10 to 20 deg give the best results if the moisture content is less than 20 per cent. In the Douglas-fir regions, cutting angles of 20 to 25 deg are most common. If green Douglas fir is being run, a 30-deg cutting angle is not uncommon. Generally speaking, as the wood increases in hardness and dryness, the cutting angle is decreased.

Oftentimes knives have a zero or even a negative cutting angle. Kiln-dried sash and door stock has been run successfully with negative-angle knives. In splitting dimension stock negative cutting angles have been used extensively to prevent tearing out of splinters by the long cutter necessary for this work.

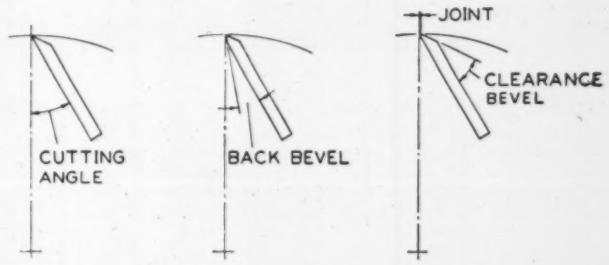


FIG. 1 ILLUSTRATING TERMS USED IN CONNECTION WITH KNIVES FOR CUTTERHEADS

Most users buy cutterheads or cylinders machined to hold knives at the maximum cutting angle found necessary for the various woods they machine. They then obtain smaller cutting angles as required by back-beveling the knife. This is by far the most economical method, especially in shops where many different woods are machined.

As cutting angle is reduced, more power is required to pull the cutter through the stock. Hence not only must more power be available but the spindle must be capable of transmitting the power and the machine must be capable of withstanding the pressure of the cut. Oftentimes lack of power is the determining factor in the application of cutterheads. Modern molders are usually provided with 7.5 to 10 hp at the profile arbor. A molder now on the market has 40 hp direct-connected to each profile arbor. This might seem to be on the high side, but tests have shown that as much as 15 hp has been consumed by a cutterhead for running casket stock when the head was not actually cutting but merely running at full speed. With the higher powers that are used by cutterheads in the modern planer, the necessity of rigid close-coupled construction is becoming increasingly important. Bearing construction is important, particularly on those profile arbors where at least one bearing must be removed so that cutterheads can be installed and removed with ease and rigid support provided.

Control of the stock in the machine is mainly a problem of the operator, but his solution is of great importance to the supplier of the cutterhead. Many attempts at running multiple stock have failed, not because of the cutterhead, but because the stock was not controlled rigidly as it left the cutter with the result that little acceptable stock was produced. If provision has not been made for proper control of the stock, multiple operations should not be considered.

SPEEDS AND FEEDS

When selecting cutterheads for a job, the type of feed that is to be used must be considered. For first-class work, the machine must be fed so that it cuts continually. If this is not

[1] Numbers in parentheses refer to the Bibliography at the end of paper.

Contributed by the Wood Industries Division and presented at the Wood Industries Meeting, Jamestown, N. Y., Sept. 27, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

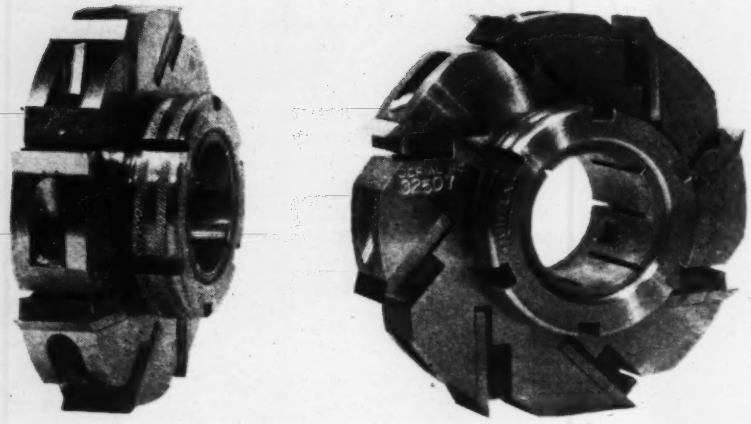


FIG. 2 8-KNIFE SLIP-ON DISK

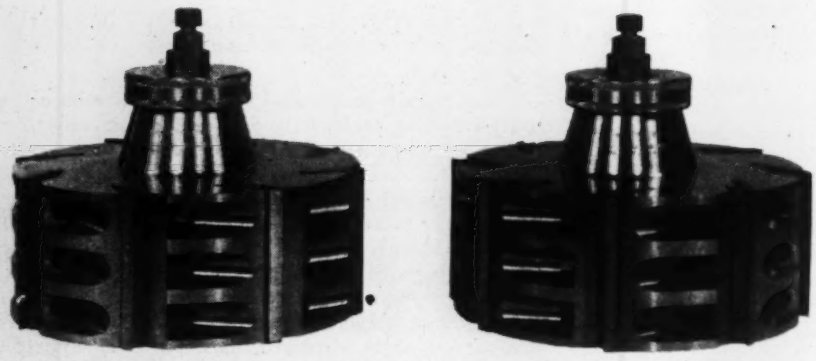


FIG. 3 8-KNIFE CORRUGATED JOINTER HEADS

done, a burn spot will appear wherever the stock was stopped by a cutterhead or cylinder. For this reason it is generally false economy to use a higher feed, and thus larger cutterheads, than can be properly supplied with stock with the type of feed available. Hand-feed machines will vary in capacity with length of stock, with 120 to 150 fpm about the maximum.

Cutterhead speeds and feeds available on a particular machine also should be considered in selecting cutterheads. Generally, most cutterheads run at one speed and one speed only, usually 3600 rpm. Some machines, usually molders, run at 7200 rpm by means of a frequency changer, and speeds of a few newer machines can be changed readily. As the speed of a cutterhead is increased, the number of cutters required decreases in direct proportion.

Woodworking machines as delivered by machine builders usually have a range of feeds that control the volume of work that can be done. These feeds have been determined by the builder as being optimum

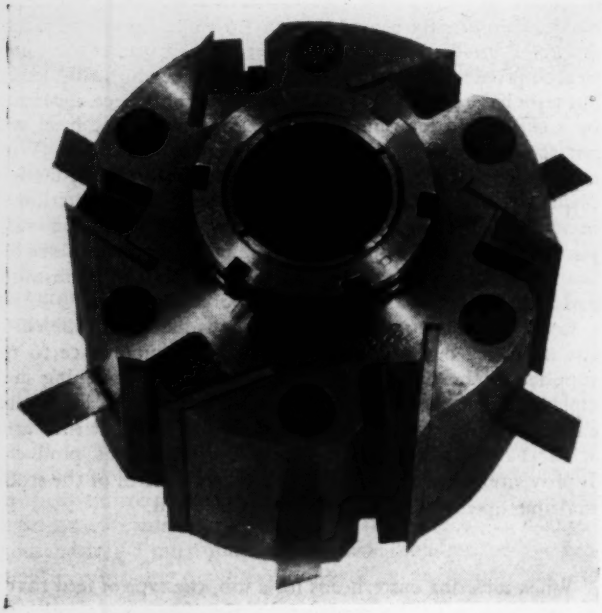


FIG. 4 6-KNIFE AND 6-PLUG SPLITTER AND SURFACER HEAD

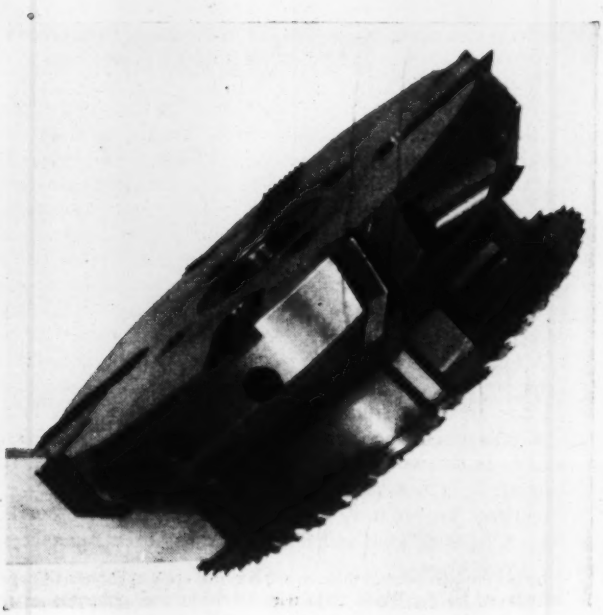


FIG. 5 SPLICER HEAD

for the machine from a design and operating standpoint. To change these feeds is usually difficult and is generally not done. Therefore any head to be used on a particular machine must be designed around the feeds available on that machine.

TYPES OF CUTTER HEADS

The quantity of work of a particular pattern must also be known in selecting the cutterhead to be used. Work will usually fall into one of three classifications, namely, (*a*) short single run, (*b*) long single run, and (*c*) frequent runs of the same pattern. Depending upon which one of these classifications a job falls into, a greater or lesser amount can be spent economically for cutterhead equipment.

Three general types of cutterheads are offered by most cutterhead manufacturers, namely, (*a*) straight knife, (*b*) milled-to-pattern, and (*c*) circular bit. The straight-knife type has many different forms. It may be equipped with either plain or corrugated back knives as in Figs. 2 and 3. Or it may be of a special design, as in Fig. 4, for splitting stock. The straight-knife type is generally used for surfacing work or when a small lot of one pattern is to be run, in which event the cutters are ground to the desired pattern. Fig. 5 illustrates a straight-knife head designed for a single-purpose job with ground-to-pattern knives. Into the classification of straight-knife heads also falls the square head which was used almost exclusively for many years. The square head, while it still has many applications, is more dangerous to operate on machines such as hand jointers where the hand can come between the head and the bed of the machine while in operation.

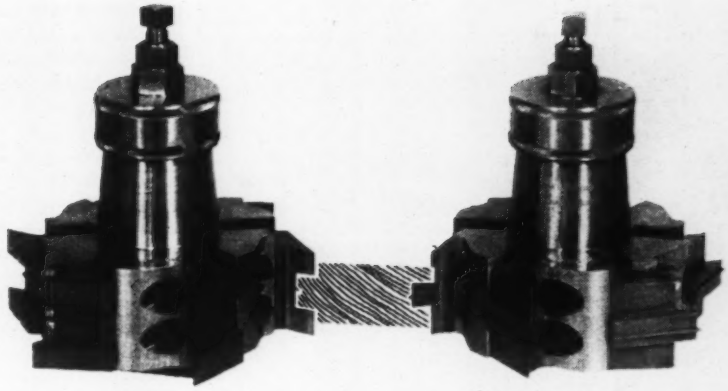


FIG. 6 6-KNIFE GENERATED (MILLED-TO-PATTERN) DOUBLE SHIPLAP HEADS

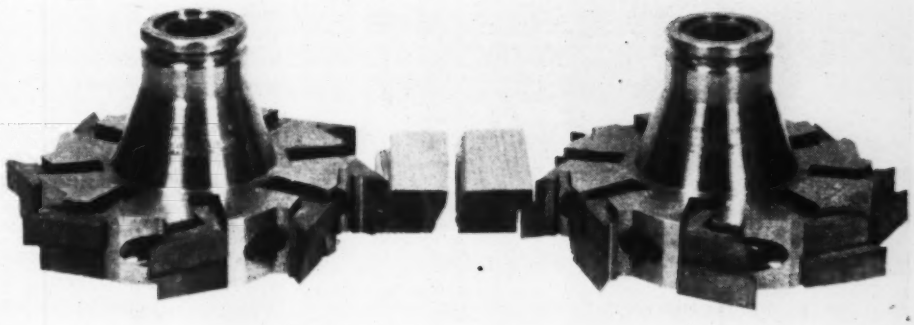


FIG. 7 8-KNIFE GENERATED (MILLED-TO-PATTERN) SHIPLAP HEADS

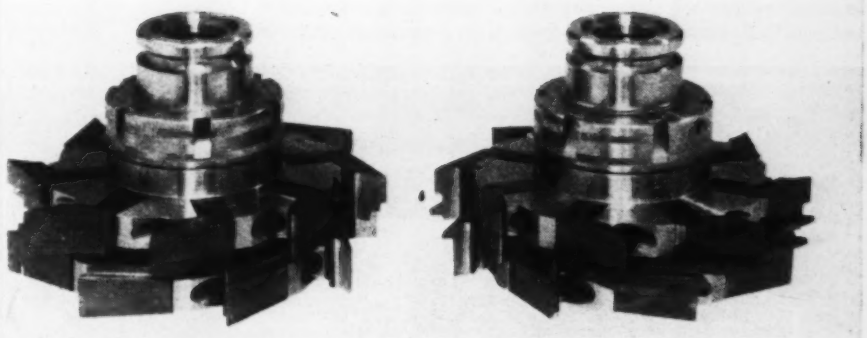


FIG. 8 16-KNIFE GENERATED (MILLED-TO-PATTERN) EXPANSION-TYPE FLOORING HEAD

Milled-to-pattern cutterheads are known by many trade names, but in basic principle the pattern is formed into the back or top of the knife in such a manner that the same pattern will be cut throughout the life of the knife. Figs. 6 and 7 show two different sizes of one type of milled-to-pattern cutterheads. Fig. 8 illustrates a special type of a milled-to-pattern cutterhead which is used by the flooring manufacturers. Fig. 9 is another type of milled-to-pattern cutterhead using knives that are flat rather than L-shaped as in previous illustrations. The economy of milled-to-pattern or form cutters on long or repeat runs is readily appreciated. Sharpening is merely a straight grinding operation across the face of the cutter with no skill required to maintain the shape used on a previous run.

Circular-bit cutterheads have the advantages of the milled-to-pattern type plus, in most instances, longer cutter life. With circular bits usually a greater number of formed cutters can be accommodated within a given diameter than is possible with milled-to-pattern knives. Cutterheads with circular bits for running flooring have been made with as many as 40 cutters in a diameter of 12 in. A head of this type is shown in Fig. 10. Circular-bit cutterheads are generally single-purpose heads and their use is usually confined to long production runs.

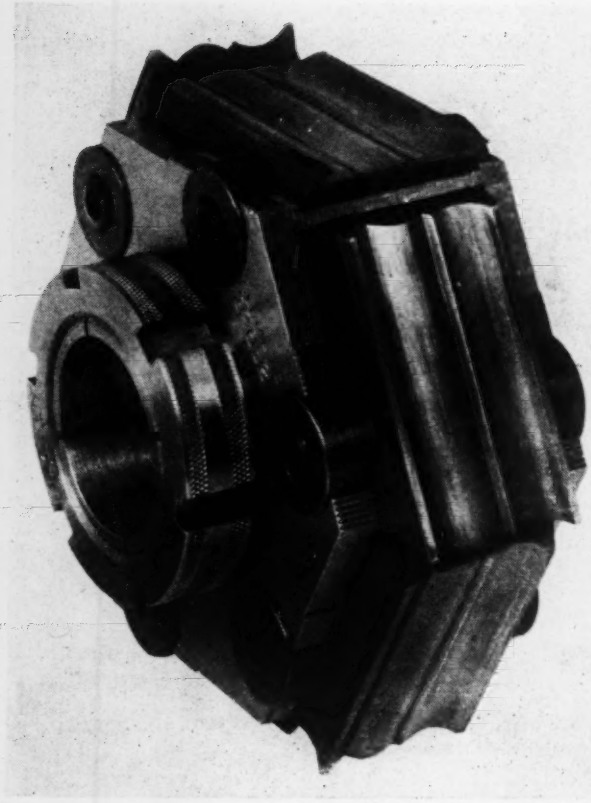


FIG. 9 6-KNIFE MILLED-TO-PATTERN MOLDING HEAD

The choice between straight-knife and the other types is generally based on the pattern to be run and the economics imposed by the lot size. The choice between a circular bit and a milled-to-pattern knife is more often a matter of operator preference except in instances where economy of the operation is the dominant factor.

Many combinations of types are used in the cutterheads manufactured for special jobs. The combination used is usually dictated by space limitations or the cutting action desired. Fig. 11 illustrates a setup for splitting 2 × 12-in. into three 2 × 4-in. pieces. The top heads are of the milled-to-pattern type, while the bottom heads are a combination of a special straight knife and a circular bit.

Many features of cutterhead design should be considered in selecting a cutterhead.

CENTERING AND HOLDING CUTTERHEADS

The method of centering and holding the cutterhead on the machine must always be considered. The need exists for standardization by woodworking-machine builders on the sizes and shapes of profile arbors and side spindles, and on the sizes of cutterheads that can be used. One might think that standardization of profile arbors, which are nothing more than straight shafts with one or more keyways, would be simple, almost automatic, but such is not the case. Some machine builders use $2^1/_8$-in. arbors as standard while others use $2^3/_{16}$ in. Recently some machines have been manufactured with $2^7/_{16}$-in. arbors. One manufacturer uses $2^1/_8$ in. diam on one model and $2^3/_{16}$ in. on another of approximately the same capacity. The situation on side spindles is just as bad or worse. One company manufactures tapered side spindles exclusively while others commonly furnish straight side spindles, except on special request, when they may or may not provide the same taper. Height above the bed line of the machine also varies with manufacturers. All these variations disturb the cutterhead manufacturer and also the user who must frequently duplicate several thousands of dollars' worth of cutterhead equipment because of lack of standardization. Standards have been worked well in the metalworking industries and it would seem that the woodworking industries could and would follow their example.

The first and simplest type of cutterhead fastening is the setscrew, bearing either directly against the shaft or against a key. There is no doubt that this will hold the cutterhead in most instances, but constant reclamping soon makes it impossible to get a true bearing that will insure good work. Even when new, a setscrew is of doubtful value as a centering device because it pulls the cutterhead sideways by the amount of clearance between the bore of the cutterhead and the outside diameter of the arbor. As will be shown later, this slight error can be enough to produce poor-appearing work. Only when cutterheads are lapped to fit one arbor, and no other cutterheads are used on that arbor, are cutterheads clamped by setscrews satisfactory; but as this type of centering device is as expensive as others, it is rarely used.

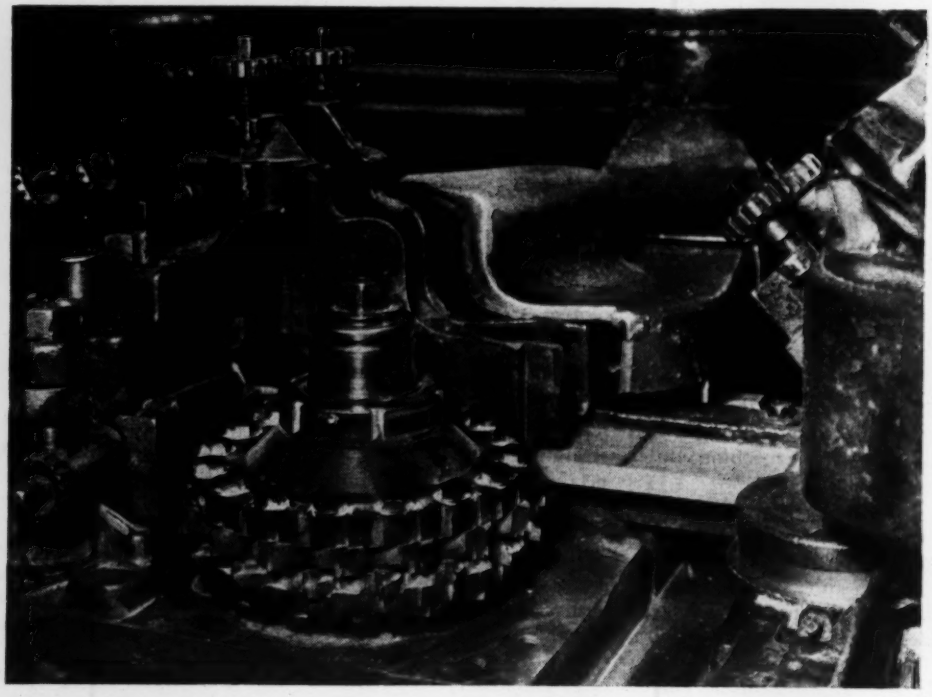


FIG. 10 32-BIT MODEL G (CIRCULAR BIT) FLOORING HEAD

Another type of centering

device that introduces serious errors because of clearance is the clamp-type collar. By forcing the centering clamp into an elliptical shape, a clamping action is obtained but nothing is done to compensate for errors caused by machining clearances.

Split cones, both double- and single-taper, are perhaps the simplest effective means of centering cutterheads. These cones may be forced into the tapered seats of the cutterhead by a nut at the end of the arbor; or they may be pulled into the head by a sleeve which has a cone at one end forming an integral part of the sleeve, and a loose cone under the nut at the other end of the sleeve. As such cones are forced into the cone seat, they collapse slightly and force the cutterhead to a central position in respect to the arbor.

Side heads are generally held on the spindle and centered by means of a thin sleeve tapered about $1^1/_2$ to 2 in. per ft. This sleeve functions like a drawbar collet chuck. As the sleeve is pulled into the head, it is collapsed by an identical taper machined into the bore of the head.

Another method of centering side heads is the use of tapered spindles in the machine. The bore of the cutterhead is machined to this taper and effective centering is obtained. It is only necessary to hold the head down on the taper to complete the application of centering and holding. This method eliminates at least one part and thus one joint, and this makes for superior performance, as the fewer the joints the more rigid the cutterhead.

CUTTERHEAD DESIGN

The material used in the manufacture of the cutterhead, while not usually left to the selection of the consumer, is important to him. The cutterhead body must withstand shock loads, heavy centrifugal forces, and abrasion. For these reasons it should be made of a type of alloy steel similar to the 3100 or 4100 series, heat-treated to the maximum hardness consistent with economical machining by the cutterhead manufacturer. The effects of abrasion vary with the woods cut; with some it has little or no effect upon the head body, while with others it is serious. Proper design for chip space will oftentimes reduce or remove this cause of failure.

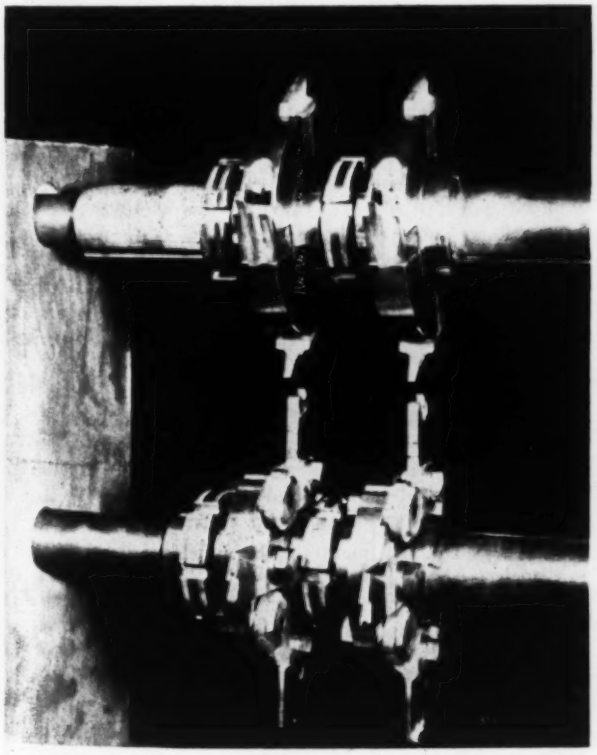


FIG. 11 TOP AND BOTTOM SPLITTER AND EASED-EDGE HEADS

Accurate machine work is necessary for satisfactory operation of a cutterhead. A cutterhead that is not concentric cannot produce quality work. To maintain concentricity, the manufacturer must adopt many methods commonly used in precision gear manufacture. When cutterheads are slotted to receive cutters, strains over relatively large areas are released. For this reason, careful uniform heat-treatment is essential. Also, spacing must be accurate so that the amount of metal in each section is uniform and will thus resist deformation equally in each section when the cutterhead is in operation. While cutterheads must be accurate, they cannot be "handmade" to the extent that cutters from one head will not work in another. This is important to the plant that uses many sets of cutters in a relatively few cutterheads. Balance, both static and dynamic, is another factor that should not be overlooked. Slight errors that affect balance are bound to creep into the manufacture of cutterheads. These must be corrected for proper operation of a cutterhead. Dynamic balancing is best; but static balance will serve if the width of the cutterhead is small in relation to its diameter.

KNIVES

Knives used in the cutterheads usually draw more attention from the consumer than the head body itself, and rightly so, because it is here that success or failure can be measured quickly. Four types of material are generally offered the woodworking trade for knives, namely, (*a*) carbon steel, (*b*) high-speed steel, (*c*) high-chrome high-carbon steel, and (*d*) knives tipped with tungsten carbide.

Carbon-steel knives are still widely used, mainly on older machines with slow feed rates and hold a keen edge for a long time; but as feed rates were stepped up in the newer machines, it was necessary to use alloy steel.

High-speed steel has found a wide acceptance in the woodworking industry. It has good abrasion-resisting qualities and can withstand considerable heat without a loss of hardness. It is generally used throughout the country with the exception of areas machining softwood. It will withstand considerably more abuse in grinding than other steels and for this reason is almost always used in molding plants where knives are ground to pattern.

High-carbon high-chrome steel has been used in the woodworking industry for about 20 years and has been found superior to high-speed steel in edge-holding qualities, particularly in the softwood areas of the West Coast. It has been used successfully by some plants machining hardwood, but generally its use has not been widespread in the East.

Most people think of tungsten-carbide-tipped knives as a postwar or wartime development as far as the woodworking industry is concerned. Actually, its use for planer knives dates back to the 1920's. Although its use at that time was not general because of high cost, it was known that it was the most economical cutting material in some applications. As recently as 10 years ago (4), there were many "don'ts" regarding carbides which since then have been greatly modified. Although the price of tungsten carbide has been greatly reduced, grinding costs are still high. To properly maintain carbide-tipped cutters, they must be ground on a silicon-carbide or a diamond grinding wheel, preferably on a diamond wheel. When a diamond grinding wheel is used the cutter grinder must be in first-class shape because the grinderman is working with tenths of thousandths instead of thousandths of an inch. This tends to make the initial outlay considerable; however, where a bad abrasion problem is encountered

the carbide-tipped cutter is often the most economical when all the losses incurred through the use of regular steel cutters are considered. Carbide-tipped cutters can be applied to most cutterheads presently in operation; only those having extreme cutting angles must be avoided. Tungsten carbide is notably weak in tensile strength and must be firmly backed up by a material of greater tensile strength. Cemented tungsten carbide should not be considered a "cure-all." There is no doubt but that it is the best solution in many cases, notably glue lines; but the total cost of its use must be weighed against the total cost of other materials. Carbide-tipped cutters are going to find an increasingly wide field in woodworking just as they have in metalworking, but their use should be justified in each case and not just accepted as being better because it is new.

In the manufacture of knives, the one point in which the consumer is most interested is having every knife in a set identical. The knives must be identical in size, pattern, alignment of pattern, and weight. If just one knife varies from the rest of the set, trouble will be encountered in getting good work from the cutterhead. Most manufacturers solve this problem by making the complete set in one setup at one time. Another factor of interest to users of milled-to-pattern knives or circular bits is the duplication of the same pattern on later orders for knives of the same pattern. Some manufacturers make a sample knife or template so that an exact duplicate is insured. This might seem to be a needless precaution; but when one considers the fact that on formed cutters which are revolved, as in a cutterhead, all curves must be corrected, and straight lines of any length that are not parallel or at right angles to the axis of rotation must be corrected by making them either concave or convex, depending upon the design, it is readily seen that samples are a "must" to be sure of true duplication.

Straight knives are of course lowest in first cost; however, they have two shortcomings when used to run patterns. After a pattern is ground into a straight knife, its life is relatively short before the pattern must be reformed. Each time the pattern is reformed a chance for error in the shape of pattern occurs. For this reason milled-to-pattern knives or circular bits are generally preferred if a considerable quantity is to be machined. Circular bits will retain a pattern closer than most milled-to-pattern knives because most milled-to-pattern knives must be advanced one or more corrugations when knives are reset. Difference in ability to retain the pattern is slight and for the most part will not be noticeable in the finished work. Circular bits, in general, give more usable cutters than milled-to-pattern knives. In some circular bits of ordinary size, as much as 5 in. of wear can be obtained.

Even after a proper selection of cutterheads and knives has been made, it is possible that difficulties may be encountered as a result of changes in material being run or improper applications.

CAUSES OF POOR QUALITY OF WORK

Poor quality of planing is usually evidenced by one or more of five defects found in the finished stock (5): raised grain, fuzzy grain, chip marks, torn grain, and knife marks.

Raised grain is defined by the American lumber standard as "a roughened condition of the surface of dressed lumber in which the hard summerwood is raised above the softer springwood, but not torn loose from it." This definition goes a long way toward explaining what has happened and a possible correction. As knives become dull and cutting pressures are increased, or if cutting pressures are increased by too little cutting angle, the harder summerwood is pressed into the softer wood. As soon as the pressure of the knife has ceased, the hard summerwood springs back by nearly the amount of the compression and gives the ripple effect of raised grain. The correction of course is a keen cutting edge with the maximum amount of cutting angle. Frequent jointing is often necessary to prevent raised grain.

Fuzzy grain is also best corrected by a keen edge. It is more often found in edge-grained than in flat-grained pieces, while the reverse is true with raised grain.

Chip marks, as the name implies, are caused by forcing previously cut chips into the surface. More chip space, either by greater knife projection or proper design on milled knives and circular bits, will tend to eliminate this defect. Insufficient blower capacity is often a contributing factor to chip marks. If the blower does not remove the chips from the cutterhead, little can be accomplished by cutterhead design to avoid chip marks.

Torn grain or chipped grain is the breaking out of particles below the line of cut. Whenever stock which has grain running at a steep angle to the surface is fed against the grain, chipping or tearing is likely to result. Smaller cutting angles and a chipbreaker close to the cutting edge are indicated when tearing is encountered. This chipbreaker may be ground into a milled-to-pattern knife or circular bit. On a straight-knife head, chipbreaking action is obtained by setting the gib closer to the cutting edge of the knife. Tearing can also be reduced on hand-fed machines by feeding stock with steep grain angles so that the grain is with the feed instead of against the feed.

KNIFE MARKS

Knife marks are a planing defect that is always with us. The severity of the defect is of course judged by its visibility. It is commonly assumed that the closer the knife marks are to each other the less they will show. Actually, it is not the spacing but the depth that is the determining factor (6). The depth of knife marks made on stock for a given cutterhead depends upon the feed and whether or not the cutterhead has been jointed (a jointed knife is illustrated in Fig. 1). There has been considerable discussion as to the merits of jointing. In all of this discussion, no one has offered any better method of test than visual examination of the stock for depth of knife marks. The one factor that can decrease the depth of

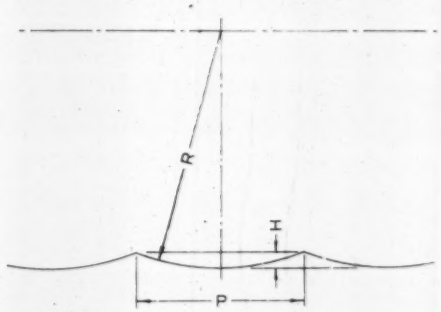


FIG. 12

knife marks and still maintain the same feed is jointing. In Fig. 12 it can be shown that $R^2 = (R - h)^2 + (P^2/2)$, where R = radius of the cutterhead, inches, P = wave length, inches, h = wave height, inches.

This gives $2Rh = h^2 + (P^2/4)$, but h^2 is so small that it may be overlooked, and hence $h = (P^2/4D)$, where D is the diameter of the cutter. Also $P = (12F/SN)$, where F = feed, feet per minute, S = rpm of cutterhead, N = number of jointed knives.

(If not jointed, N must be assumed to be unity.)

By substitution $h = (36\ F^2/DN^2S^2)$. This formula (7) is subject to two small errors, the omission of the h^2 factor and the assumption that the waves are circular arcs. This is not exact as the waves are parts of cycloids and not circles. However, both errors are so slight that they will not materially affect the conclusions drawn from the use of the formula.

By the use of the formula it can be shown that for a four-knife jointed cutterhead, 8 in. in diameter, turning at 3600 rpm with stock being fed at 50 fpm, a wave height of 0.0000544 in. is obtained. If this same set of conditions is maintained without jointing, a wave height of 0.0007604 in. is obtained. The difference, 0.000706 in., is the amount by which one knife would have to project to wipe out the knife marks of the other three knives. Although it can be shown that the shorter knives are doing up to 98 per cent as much work as the longest knife in an unjointed set (8), the fact remains that the degree of quality for a given set of conditions as measured by depth of knife marks depends directly upon jointing or not jointing. If a cutter is to be jointed, it has been a generally accepted fact that it should be done at full operating speed so that deformation of the head and cutters might be corrected in the jointing. When dealing with figures of the magnitude of 0.0007 in. and smaller, it would seem that for an accurate joint the cutterhead not only should be turning at full speed but should be under a cutting load also. Possibly the failure to do this is the reason that jointing has not been generally successful at speeds above 3600 rpm.

JOINTING

One of the more reasonable arguments against jointing has been the pounding of the surface by the "heel" or jointed portion of the knife (9). There is no denying the fact that any portion of the knife which does not have clearance will contact uncut material as the stock is advanced and must force it out of the way. However, if a cutterhead is properly jointed pounding will be no greater than that caused by a single unjointed knife. In an unjointed cutterhead one knife projects farther than the rest of the set; because of this, the one knife must cut more and thus will dull more rapidly than a knife in a jointed set where each knife is cutting an equal amount. As this dulling takes place, the clearance on that particular knife is lost the same as in jointing but not in a uniform controlled manner possible in jointing. Thus the operator of an unjointed head soon has one knife pounding comparatively heavily while the other knives are not touching the finished surface at all. This certainly will produce stock of poorer quality than a jointed head with each knife cutting equally. While a joint of 0.060 to 0.090 in. is not uncommon on softwoods being run at high feed rates, a joint of 0.010 in. would be a heavy joint for cabinet work.

From the foregoing it can be seen that slight variations and errors in cutterheads will cause planing of poor quality. For this reason every precaution must be taken by the operator not to distort the cutterhead when working upon it. Cutterhead bodies are often badly sprung by improper tightening of knives or by setting them out from the head body farther than had been intended when the head was designed.

OTHER CAUSES OF POOR WORK

Two of the most common complaints about knives are too rapidly dulling and cracking. One is inclined to assume that the knife is too soft or too hard, but such is not usually the case. More often than not the knife that appears to be soft is not soft at all but is being used in an application not suited to the particular grade of steel or is not cutting a chip at each revolution. This latter is a common cause of failure. Most operators are inclined to reduce the feed when knife trouble is experienced. This causes more rubbing and less cutting, and soon all that is being cut is wood dust and cutters dull rapidly. Cracked cutters are often the result of a hard grinding wheel which heats the cutter excessively so that cracks develop. Another common cause of cracking is using a dull cutter. Dull or heavily jointed cutters will not cut as freely as properly sharpened cutters. When cutters are rubbing instead of cutting, they will overheat and cracks will develop.

Foreign matter is also a cause of poor work from many cutterheads. No one would think of assembling a ball or roller bearing that was not thoroughly cleaned. The same person will place a cutterhead on a spindle that has on it a pitch or gum deposit heavy enough to be seen and then expect good performance from the cutterhead. Failure of the centering device to work properly is often caused by hammering it on or off the machine. This will not only spring the sleeve or cone but the peening action will raise the metal and cause the cutterhead to run out of round.

Proof that the factors discussed can be combined for successful operation is found in the fact that feeds up to 900 fpm have been used; that work in excess of 200,000 lineal feet per 8-hr shift has been machined on a single machine; and that cutter life of 36,000,000, 70,000,000 and 154,000,000 lineal feet has been attained by different types of cutters. These are of course outstanding figures and are given only to show what has been accomplished in a few cases and not as an average that can be attained in any plant.

OTHER USES FOR CUTTERHEADS

While this paper has been concerned with the use of cutterheads as applied principally to the woodworking industries, it is recognized that cutterheads have a place and are being used in several other industries. However, such use has not been over a sufficient period of time to set a definite pattern. Wallboard, cork, plastics, paper, and other products are among those machined by cutterheads. Also, some of the light-metals industries are using cutters that could be classed with cutterheads almost as readily as they can be with milling cutters.

In the selection of a cutterhead, the finish required, the type of wood, the machines available, and the quantity to be run all have to be considered. Each of these factors can bring to light many individual problems. Once a properly selected cutterhead has been placed in operation, its performance is largely a matter of treating the cutterhead as a precision cutting tool. Particular emphasis should be put on the word "cutting." Most troubles encountered with cutterheads can be corrected by analyzing the cutting action that is taking place. Cutterheads are built to do precision work and will give many years of excellent service if cared for in a reasonable manner.

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TESTING MATERIALS *at* HIGH TEMPERATURE

By F. G. TATNALL

MANAGER OF TESTING RESEARCH, THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, PA

PRESENT practices and current opinion on methods of testing materials at high temperatures have shown that five such tests are in common use, that methods and equipment vary to some extent, but that both are being improved through the availability of new equipment which gives closer control and requires less attention by the operator. This concensus is based on data collected during visits with many of the major American manufacturers of gas turbines, turbojets, oil-refining equipment, furnace parts, and other equipment in which materials are used at temperatures as high as 2200 F, and with makers of alloy steels for high-temperature service.

Since the whole art of high-temperature testing is comparatively new, opinions and practices may change rapidly. Consequently this summarization must be understood to picture only present conditions.

The five tests that are commonly made at high temperatures are: (1) short-time stress-strain, (2) stress-rupture, (3) creep, (4) relaxation, and (5) fatigue. Torsion tests and others are also made at elevated temperatures.

Heat and temperature control of specimens during all of these tests is usually provided by electric-resistance furnaces, utilizing thermocouples in various positions for temperature control. Each furnace has its own separate controller. A recorder, however, may be connected to several furnaces. An exception to this furnace procedure was found in stress-rupture tests of sheet specimens, which were heated by their own resistance by means of welding-transformer current.

SHORT-TIME ELEVATED-TEMPERATURE TESTS

Quickly determined and approximate stress-strain relationships are adequate when a large number of possible materials are being compared to determine those which merit more accurate and detailed tests. Manufacturers of valves and fittings for oil-refinery service are extensive users of this test. Stress-strain curves, obtained at temperatures ranging up to 1600 F, have been giving satisfactory approximate values for these selections.

A universal testing machine of 60,000 lb capacity is commonly used for preliminary tests, and one or more furnaces may be mounted on the columns, each with separate controller. An additional furnace makes it possible to bring one specimen up to temperature while another is under test. Fig. 1 shows how tests are speeded up in one industrial laboratory.

Stress-strain records are obtained with an extensometer having arms that reach up into the furnace and are attached to the gage length of the specimen. Some of these arms are machined and some, of such materials as vitallium, are precision-cast. Gage points are usually made of stellite and contact the specimen at four or more opposite points around its circumference.

STRESS-RUPTURE TESTS

Stress-rupture tests at temperatures ranging up to 1600 F usually are carried out for periods ranging from 10 to 1000 hr. The specimens, $^1/_4$-in. or $^1/_2$-in. threaded rounds or sheet

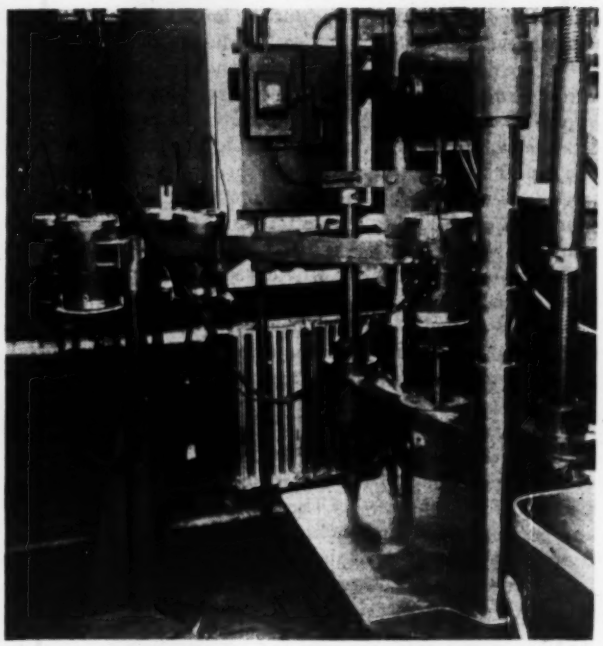


FIG. 1 HIGH-TEMPERATURE TENSION TESTS ARE SPEEDED UP BY USING SIX FURNACES FOR PREHEATING SPECIMENS

(Furnaces slide into position by aligning the rotating frame with a track, which is supported by one of the screws of the testing machine.)

centered in a furnace, are usually loaded, as in creep tests, by means of dead weights applying tension through a lever arm held in a structural steel frame.

For temperature control, the thermocouple may be attached to the furnace wall, or it may penetrate the core of one or both ends of the specimen to the shoulders, or it may be wired to the specimen near the fillets.

Rupture tests under different stresses at constant temperature give data for a stress versus time-to-rupture curve. A family of such curves may be obtained by making tests at different temperatures. These curves are substantially straight lines sloping downward from left to right when plotted on log-log charts. Total deformation of the specimen at rupture is always measured, but deformation versus time characteristics are frequently considered of secondary importance and may be omitted. Deformation measurement may be crude, as by means of a dial indicator which shows the movement of the upper grip.

When more accurate deformations are required, an extensometer is used. The extensometer is usually a platinum tube or strip attached to the upper shoulder of the specimen and sliding in another platinum tube or guide attached to the lower shoulder. Attachment is not made to the gage length. Extension is measured by observing marks on the sliding parts

FIG. 2 THIS BALDWIN SCREW-TYPE STRESS-RUPTURE MACHINE IS DRAWING A TIME-DEFORMATION CURVE ON ALLEGHENY LUDLUM S-590 MATERIAL AT 25,000 PSI AND 1350 F
(The machine is aligned with four lever-type creep machines.)

through a quartz window located in the center of the furnace.

A self-indicating extensometer of the motor-driven follow-up contact type, which indicates strain at a glance on a revolution counter, is used to some extent. This instrument is attached at pinholes in the shoulders of the specimen, and deformation is indicated in increments of 0.000025 in.

When two or more tests are being conducted simultaneously, there is a separate controller for each furnace, and one multiple-point recorder for all furnaces.

A new type of machine, recently announced by the author's company, and developed by Westinghouse Research Laboratories, applies tensile loads as high as 20,000 lb through a flat-spring dynamometer. A motor rotates a screw to maintain constant load. A deformation-time curve may be plotted automatically on a chart which moves with the specimen holder. Fig. 2 shows one of these machines in a leading steel-manufacturer's laboratory.

The data considered essential for engineering design, as a measure of material performance, stability, and other qualities, include another family of curves of log-stress versus log-creep rate which slope upward from left to right and cross the stress versus time-to-rupture curves.

CREEP TESTS

In creep tests deformation must be measured accurately which makes extensometers mandatory. The lever-and-weight apparatus (Fig. 3), is much the same as that for stress-rupture tests. Temperatures as high as 2200 F have been applied commercially, and up to 3000 F in special research on molybdenum. In some materials it has been found that stress-rupture may be the governing test at highest temperatures. Uniformity of temperature over the gage length has been found to be a most important factor. In some tests, in which the temperature was oscillated between two limiting values, the creep rate was greatly accelerated. For close temperature control, proportioning controllers, which avoid off-and-on action, are becoming popular. A constant-temperature room also seems desirable for these tests. One ingenious control of furnace temperature takes advantage of the expansion of the inside wall of the furnace, which is a stainless-steel tube. Creep rates also have been studied at Westinghouse with a controlled atmosphere surrounding the specimens.

Tensile-creep test data are plotted as curves of strain versus time at constant stress and temperature. Usually a family of curves, for several stresses, are plotted on one chart from which

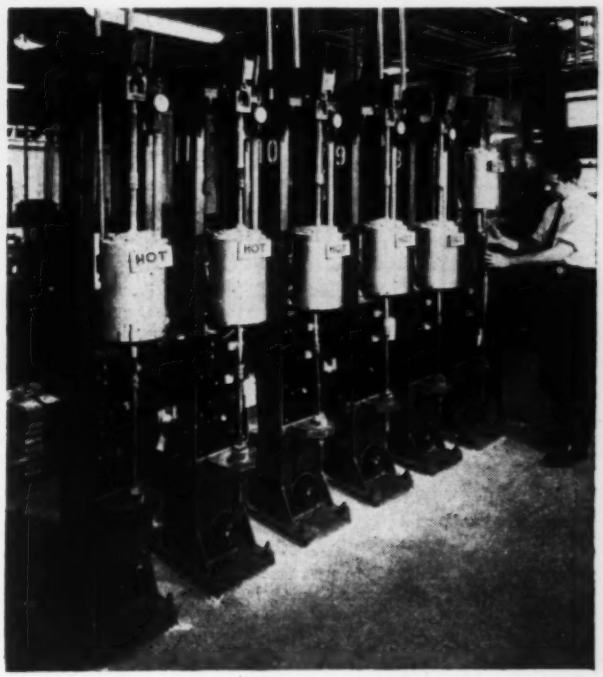


FIG. 3 CREEP TESTS AT ELEVATED TEMPERATURES USING BALDWIN LEVER-ARM CREEP MACHINES IN THE LABORATORY OF PRATT & WHITNEY AIRCRAFT, EAST HARTFORD, CONN.

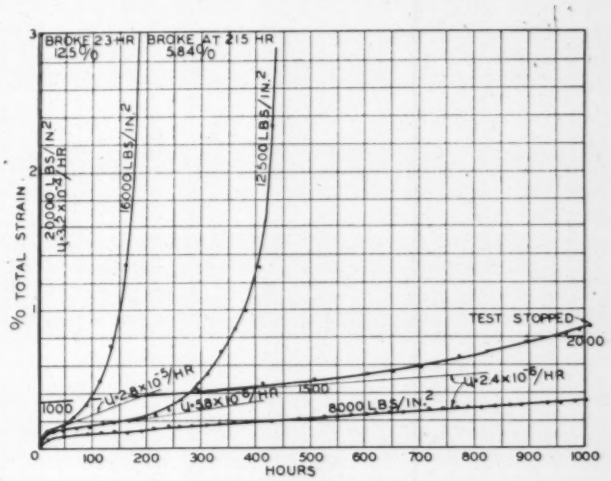


FIG. 4 TYPICAL TENSILE-CREEP TEST DATA FOR A HIGH-TEMPERATURE, NICKEL-BASE GAS-TURBINE ALLOY SUBJECTED TO FOUR STRESSES AT 1500 F

stress-time curves can be plotted for various values of total strain as required for design. Fig. 4 shows curves of this type.

Among the interesting developments in creep testing are ceramic grips which are used at the U. S. Bureau of Standards. These grips have remarkably high-temperature hardness and stiffness. The unit creep frame, such as the Baldwin-Westinghouse and American Brake Shoe types are now encountered more frequently. They offer convenience in installation and also prevent the jar of a breaking specimen from being communicated to others in the creep room.

The proper loads to apply in a creep or rupture test are usually determined by one of two methods. Preliminary trials may be made at a few different loads in (1) a stress-rupture machine, or (2) a constant-strain-rate machine. Specimens may be pulled in a wide range of strain rates, at the desired temperature, and stress-strain curves plotted. Enough points are obtained for a curve showing hot strength at various strain rates, and the curve is extrapolated back to the creep rate that is desired. An extended curve of true stress versus strain rate derives its slowest rates from creep tests, its intermediate rates from rupture tests, and its faster rates from tests on a constant-

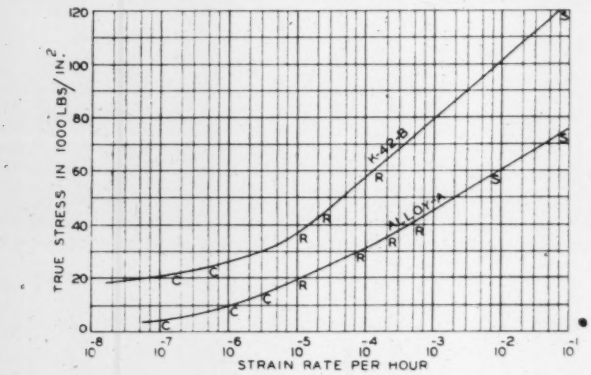


FIG. 5 AN EXTENDED CURVE OF TRUE STRESS VERSUS STRAIN RATE SHOWS ITS SLOWEST RATES FROM CREEP TESTS, INTERMEDIATE RATES FROM RUPTURE TESTS, AND FASTER RATES FROM TESTS ON A CONSTANT-STRAIN-RATE MACHINE

strain-rate machine, as shown in Fig. 5. From this curve, stress-rupture test stresses are usually set up to give strain rates of 10^{-3}, 10^{-4}, and 10^{-5} per hr, and for the creep programs 10^{-6}, and 10^{-7} per hr.

RELAXATION TESTS

The relaxation test gives stress-time relationships with strain and temperature constant. This test is particularly important for bolting stock because it reproduces conditions in a tightened flange bolt at a given temperature. It is also interesting in studying stress relief, which is a form of relaxation. Many special machines have been devised to hold strain constant. Baldwin has made available a tension-relaxation machine developed by Westinghouse, which simplifies the test (Fig. 6). It is built on a unit frame with stress-time recorder mounted integrally.

HIGH-TEMPERATURE FATIGUE

High-temperature fatigue tests are important in determining the qualities of materials for turbine blades, which sometimes must withstand an average of 30 billion changes of stress in a life of only 1000 hr. In a turbine blade, centrifugal tension is superimposed upon flexure caused by nozzle impingement on the blade.

The method of testing turbine blades is controversial. Some

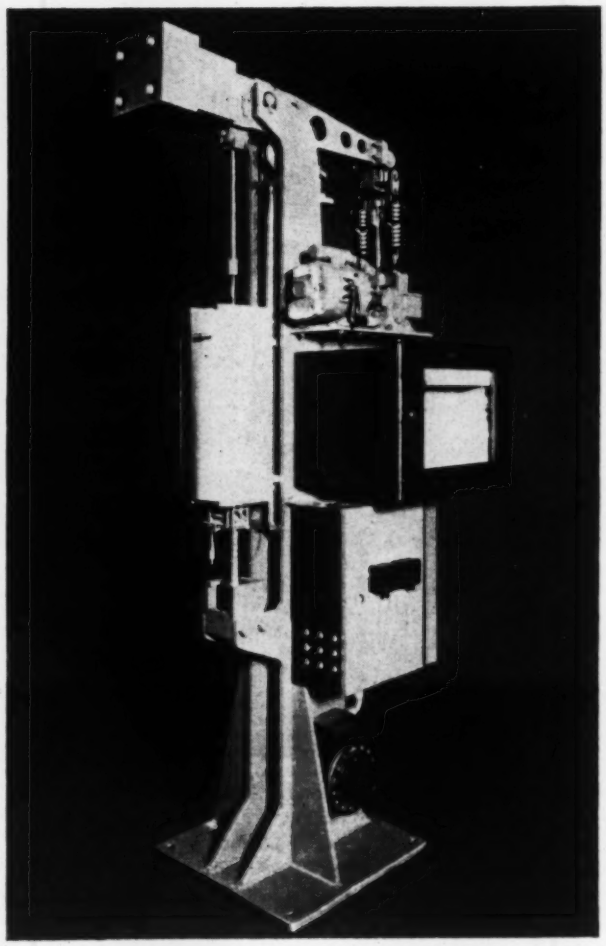


FIG. 6 THIS RELAXATION TESTING MACHINE IS THE LATEST DEVELOPMENT FOR TESTS AT ELEVATED TEMPERATURES

(The machine automatically relaxes tensional loads from as high as 40,000 psi while maintaining constant strain, and records a curve of stress versus time.)

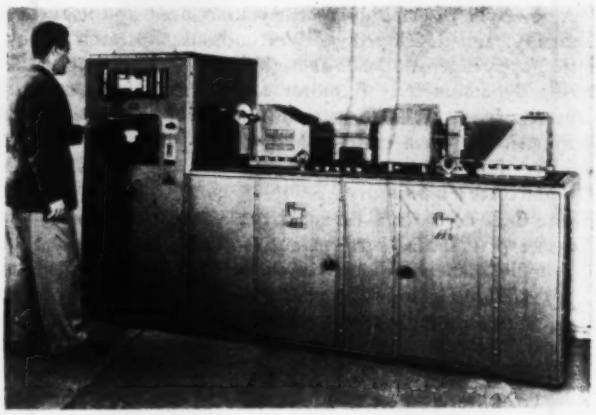


FIG. 7 THIS TURBINE-BLADE FATIGUE MACHINE WAS DESIGNED TO SUBJECT TURBINE BLADES AND MATERIALS TO FATIGUE LOADS UNDER CONDITIONS SIMILAR TO THOSE IN HIGH-TEMPERATURE TURBINE SERVICE

FIG. 8 FATIGUE TESTS ARE MADE AT ELEVATED TEMPERATURES IN THE MECHANICAL-METALLURGY LABORATORY, BUREAU OF MINES, OTTAWA, ONTARIO CANADA, USING THE BALDWIN-SONNTAG SF-4 MACHINE

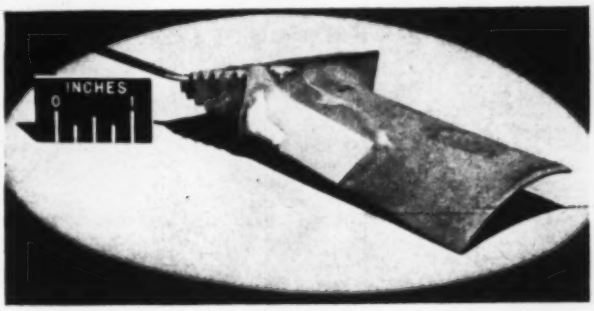


FIG. 9 THIS TURBINE BLADE IS TYPICAL OF THOSE UPON WHICH THE EFFECTS OF VIBRATION ARE BEING STUDIED

(In this instance operating tests were made by means of bonded resistance-wire strain gages in the turbine, as shown in Fig. 10. The white area is a ceramic insulating cement covering gage and lead wires which are in two tubes emanating from base of blade.)

believe that the test machine should impose static tension upon the specimen while it is alternately flexed in a furnace, as in the machine illustrated in Fig. 7. Others believe that alternating tension in the upper fibers of the flexing blade adds to the static tension while dynamic compression subtracts, allowing tension to govern.

Similarly, opinion differs as to the proper shape of a specimen. Some believe that it should be blade-shaped for various reasons, principally because varying from fine to coarse to fine grain structure in such an irregular shape influences life and the thermal shock. Cast and forged blades, especially the former, have islands of large grains with low creep rate, surrounded by small grains at the leading and trailing edges, whose higher creep rates throw the load on the large grains.

Round specimens are favored by some, not only because they are standard in other high-temperature tests, but also because this shape is thought to eliminate some indeterminate variables in fatigue.

Since actual operating conditions cannot be reproduced for laboratory tests, it appears desirable to compare materials with as many uncontrollable variables as possible eliminated.

In addition to evaluating the service performance of a material to some extent, fatigue tests bring to bear a rapid straining rate, the effect of which may differ from the slow straining rate of a rupture test. Such tests also show the effect of superimposed vibration on rupture strength, and they provide data for plotting fatigue strength at temperature against rupture strength. British engineers emphasize the value of the latter because it shows whether or not fatigue or rupture governs failure. In some instances vibration up to certain small values of alternating load increases rupture strength, as has been shown by British investigators.

Thermal shock is not evaluated in these mechanical tests. This is a penalty for varying section in a blade, thin edges heating and expanding faster than the thick blade center. Some contend that alternating loads at high temperature have less influence than the time at temperature. A combination of both can be applied and studied by means of the machine shown in Fig. 8, which is arranged for stress-rupture tests upon which can be superimposed anything from light vibration to alternating loads that can remove all load, then double the load 3600 times per min.

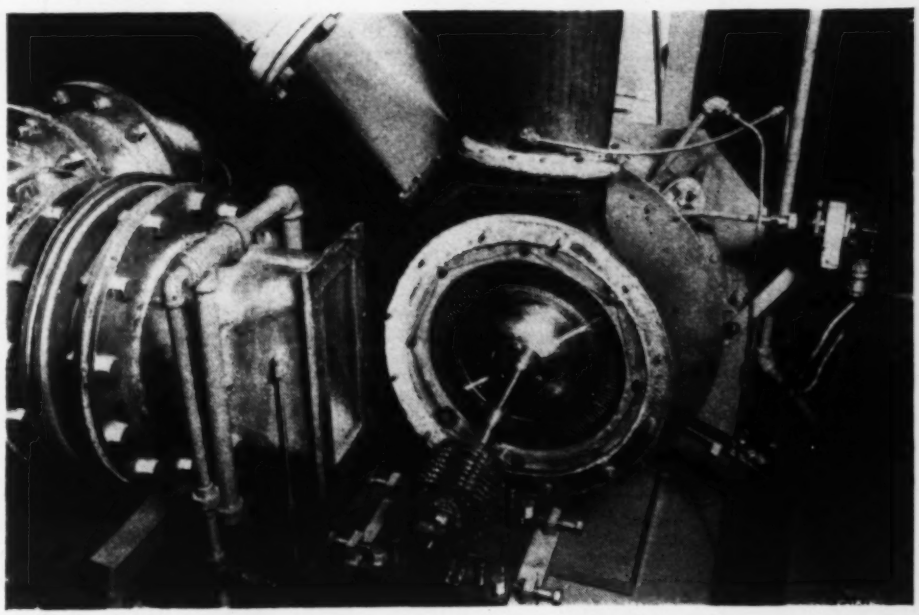


FIG. 10 HIGH-TEMPERATURE TESTS ARE BEING MADE ON OPERATING ENGINES, TURBINES, ETC., BY MEANS OF BONDED RESISTANCE-WIRE STRAIN GAGES

(Two high-temperature gages are shown here mounted at the bases of two turbosupercharger blades. White radial lines are heat-insulating coating for lead wires. Wiring passes into shaft to a set of slip rings and brushes in foreground. These tests were conducted in the Lewis Laboratory of the National Advisory Committee for Aeronautics.)

Fatigue machines have been developed commercially in a variety of forms. The Baldwin-Sonntag high-temperature fatigue machine is one of five leading commercial machines. The latest, the turbine-blade fatigue machine in Fig. 7, provides the equivalent of a dead tensile load up to 8000 lb upon which may be superimposed either a vibration or an alternating flexure load up to plus or minus 1350 lb at a frequency of 3600 cycles per min.

Like other Sonntag machines it is a "constant-force" machine, the alternating load being produced by an eccentrically mounted revolving mass.

Two types of machines use magnets to flex a round bar in a furnace. A pneumatic machine flexes a blade shape at resonance. There are also machines which operate on either the rotating-beam principle or a crank-operated constant-deflection system with an accessory electronic load maintainer. The application of high-temperature strain gages to vibratory stresses in gas-turbine buckets has been reported by Kemp, Morgan, and Manson.[1] Figs. 9 and 10 show how these tests were made.

Although emphasis has been placed here on high-temperature fatigue of turbine blades, there are of course many other applications where metal parts are subjected to fatigue at elevated temperatures. Materials and parts are being tested at elevated temperatures in an increasing variety of tests. The torsion testing machine in Fig. 11 is one that is especially adaptable for high-temperature use. This method was strongly advocated by Dr. Albert Sauveur.

[1] "The Application of High-Temperature Strain Gages to the Measurement of Vibratory Stresses in Gas-Turbine Buckets," by R. H. Kemp, W. C. Morgan, and S. S. Manson, National Advisory Committee for Aeronautics, Technical Note No. 1174, April, 1947.

FIG. 11 TORSION TESTS ARE MADE AT ELEVATED TEMPERATURES IN THE LABORATORY OF M. W. KELLOGG COMPANY, USING A BALDWIN TESTING MACHINE

Heavy-Duty BEARINGS *With* INTERMITTENT OSCILLATORY MOTION

By R. R. BUSH

DEVELOPMENT ENGINEER, SWITCHGEAR DIVISION, GENERAL ELECTRIC COMPANY, PHILADELPHIA, PA. MEMBER ASME

INTRODUCTION

FRICTION in journal bearings has been the object of continued study since the invention of the first machine. A vast amount of literature is published covering studies which have been made on this subject. As most of such bearings normally operate under conditions of continuous rotation with intermittent periods of rest, most of the published literature confines itself to these conditions. Such bearings normally require rather frequent attention and a supply of lubricant that can be conveniently renewed. This lubricant is carried continually into the bearing by the rotating action of the shaft in the bearing. In some bearing applications, such as power circuit breakers, however, no such continual shaft rotation is present to carry lubricant into the bearing. Either they may operate dry or with grease which may be inserted either at assembly or forced in under pressure. Circuit-breaker bearings are unique in that their rotation is confined to a fraction of one revolution in most instances, and operations may be frequent or extremely infrequent. In fact, many operate so infrequently that if the duration of all the operations of the circuit breaker during 20 years' service were added together, the total time of operation might easily be as little as a single hour. Seldom would it be greater than 10 hours.

Despite this limited movement, however, which eliminates any possibility of carrying lubricant into the bearing, the circuit breaker must stand ready to operate and interrupt a dangerous short circuit at high speed on an instant's notice. To do so, every bearing in the circuit breaker must operate with a minimum of friction regardless of the length of time which has elapsed since the last operation. Published data on this type of bearing service is practically nonexistent. However, this does not eliminate the problem, a problem which circuit-breaker manufacturers have studied with each new circuit-breaker design to provide the highest degree of operating reliability.

A power circuit breaker consists essentially of a large switch with means for extinguishing arcs. It has stationary contacts on each phase of an electrical circuit connected and disconnected by moving contacts. Generally speaking, springs oppose the closing of the moving contacts and account for a large part of the power required to close them. The quick opening is accomplished by a release or trip which allows the springs to come into play. Each passing year has seen the duty on circuit-breaker bearings increase, both as regards bearing pressures and bearing speeds.

Fig. 1 illustrates a relatively early type of circuit breaker, rated 2500 volts with an interrupting rating of 15 mva with the oil tank removed.[1] The mechanism operating speeds were comparatively slow and the bearing loads relatively light. Simple overload tripping and manual operation were the rule. As the electrical power systems grew, short-circuit currents increased, and larger and faster circuit breakers became necessary to prevent damage to valuable apparatus. To obtain maximum continuity of service, circuit breakers were developed to provide high-speed clearing and reclosing of circuits.

Fig. 2 is a circuit breaker recently developed which has a rating of 360,000 volts, 10,000 mva. It was designed to open its 6 sets of 1000-amp contacts in 0.05 sec and reclose them in 0.167 sec. As a matter of comparison of size, the inset at the lower left-hand corner shows the breaker in Fig. 1 to the same scale as this modern breaker. Without the improvements both in circuit-breaker bearing design and in bearing materials, which occurred in the intervening years, the latter designs would not have been possible. Fig. 3 represents the general development of the characteristics cited in a chronological relationship.

BEARING REQUIREMENTS FOR MODERN CIRCUIT BREAKERS

As previously stated, the operating requirements for bearings on circuit breakers are quite different from those found in most apparatus or machines. This can be illustrated by considering a motor generator set such as Fig. 4, which develops 50 hp and runs at 3600 rpm. The surface speed of the shaft in the bearings is approximately 35 fps, and the bearings are lubricated by oil and run with pressures in the order of a few hundred pounds per square inch. The surface speeds on typical circuit-breaker shafts or pins, on the other hand, are less than 10 per cent of the motor-shaft speed. The loads per square inch on these bearings, however, are many times higher, ranging from 2000 to 10,000 psi of projected bearing area, depending upon the particular application. In fact, peak pressures may go considerably higher than 10,000 psi. These high bearing loads are a result of the heavy spring forces used to obtain high-speed acceleration of the breaker contacts. Pin and shaft diameters, moreover, are kept as small as possible to limit the diameter of the friction circles. A typical application of such bearings is in the mechanism of the magne-blast circuit breaker shown in Fig. 5.

Most power circuit-breaker shafts rotate through limited angles when opened; the majority through less than 60 deg, while few rotate more than 120 deg. The closing operation generally reverses through the same angle. Breaker mechanisms consist principally of cranks rotating backward and forward as the breakers close and open. During this motion the load generally varies considerably. As an example, during the closing of a breaker, opening springs and contact springs are encountered in a sequence such that the final forces are anywhere from 5 to 25 times the starting load, depending on the type of breaker. Fig. 6 is a typical force-travel curve at the actuating mechanism of a circuit breaker requiring average operating forces.

[1] Mva = megavolt-amperes = million volt-amperes.

Contributed by the Machine Design Division and presented at the Fall Meeting, Erie, Pa., September 28–30, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

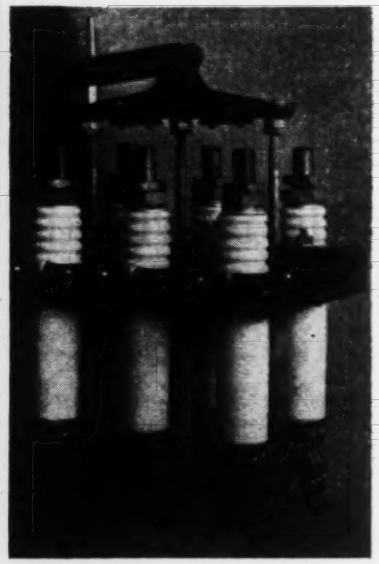


FIG. 1 OIL CIRCUIT BREAKER WITH TANK REMOVED
(This breaker of 1925 vintage used brass pins in steel links. Height over-all $2\frac{1}{2}$ ft.)

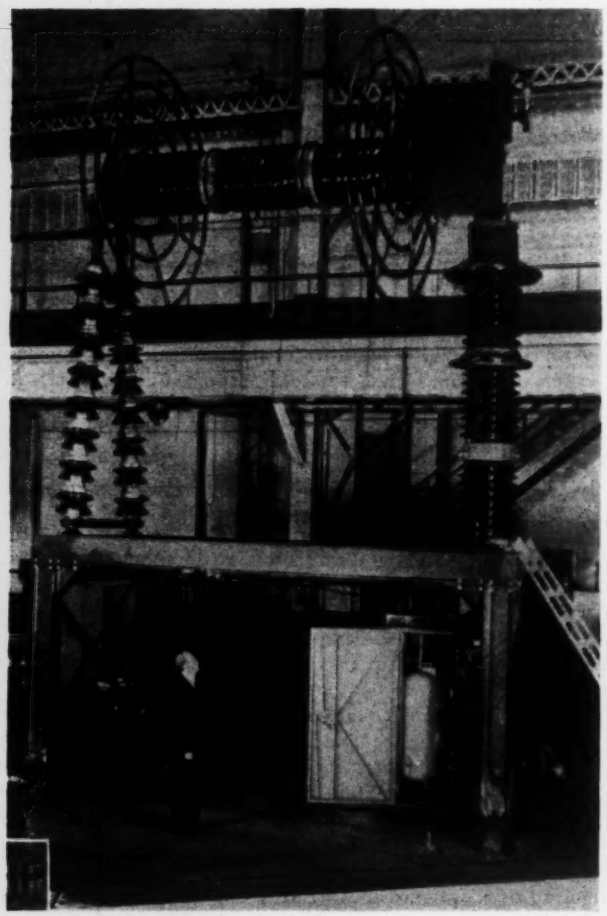


FIG. 2 LOW-OIL-CONTENT IMPULSE-TYPE OIL CIRCUIT BREAKER
(Rated at 10,000 mva and 360 kv. Interrupting time 0.05 sec; reclosing time 0.167 sec. A modern breaker with modern bearings. Height over-all 28 ft. Inset of breaker from Fig. 1 compares sizes.)

Historically, a large combination of materials has been used for circuit-breaker bearings. When circuit breakers were first built for light loads, plain-steel pins and steel bearings usually were used. As loads increased, abrasion was encountered, and steel pins and brass bushings were substituted. In some cases it was more convenient to use brass pins directly bearing in steel. Fig. 7 is an example of bronze pins in both cast steel and malleable cast iron. With the use of nonferrous metal, rusting and corrosion were reduced greatly. The coefficient of friction also was reduced with the use of steel and brass. Later, in order to reduce corrosion, stainless-steel pins were adopted. When stainless-steel pins and bronze bushings were used, a decrease in the coefficient of friction was again realized.

TEXTOLITE COMPOUND BEARINGS

In the past few years the number of operations to which some circuit breakers are subjected has increased greatly. A considerable number of new materials has been studied to determine what materials or combinations of materials might be used for circuit-breaker bearings to obtain even lower coefficients of friction, longer life, higher permissible loadings, or less frequent lubrication. For this intermittent duty where heating was not a limiting factor, a much wider range of materials and combinations of materials could be considered than is possible for continuously rotating bearings. Of the various bearing materials which have been tested, textolite tubing made of cotton cloth and thermosetting phenolic resin has proved to be far superior to any of the metallic materials. When used

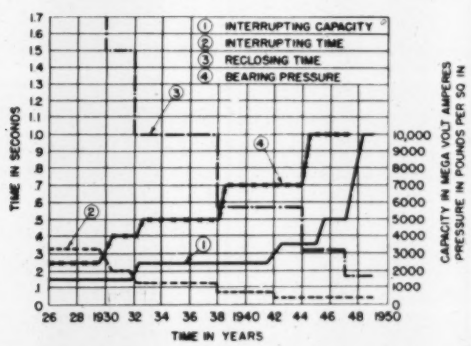

① INTERRUPTING CAPACITY
② INTERRUPTING TIME
③ RECLOSING TIME
④ BEARING PRESSURE
TIME IN SECONDS
CAPACITY IN MEGA VOLT AMPERES
PRESSURE IN POUNDS PER SQ IN
TIME IN YEARS
26 28 1930 32 34 36 38 1940 42 44 46 48 1950

FIG. 3 GENERAL CHRONOLOGICAL DEVELOPMENT OF ALLOWABLE BEARING PRESSURES COMPARED TO OTHER POWER CIRCUIT-BREAKER CHARACTERISTICS

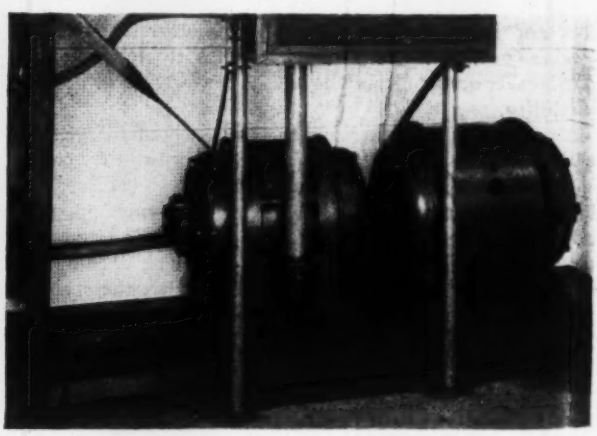


FIG. 4 MOTOR-GENERATOR SET FOR VARIABLE-FREQUENCY OUTPUT
(Maximum horsepower 50 at maximum of 3600 rpm. Bearings must operate continuously at high speed and relatively low loading with oil lubrication.)

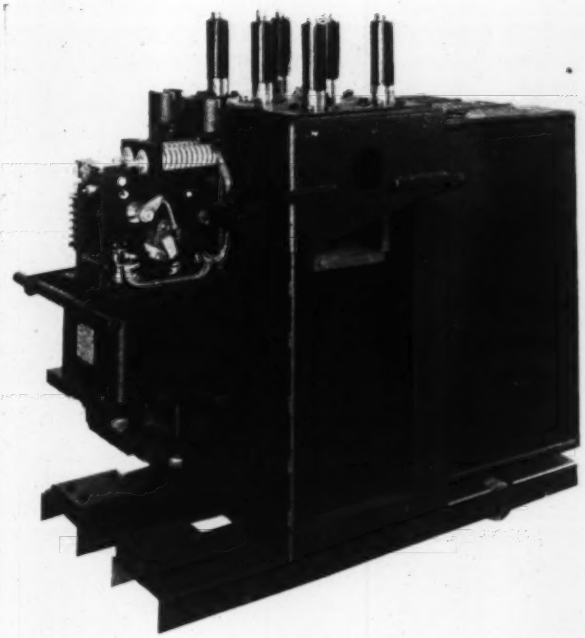


FIG. 5 MAGNE-BLAST POWER CIRCUIT BREAKER

(Rated 500 mva at 15,000 volts. Bearings must operate instantly but intermittently at medium speed and relatively heavy loading. Height over-all 4½ ft.)

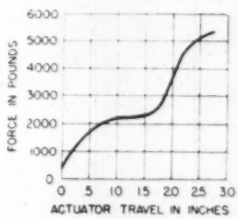


FIG. 6 TYPICAL FORCE-TRAVEL CURVE OF CIRCUIT-BREAKER ACTUATOR

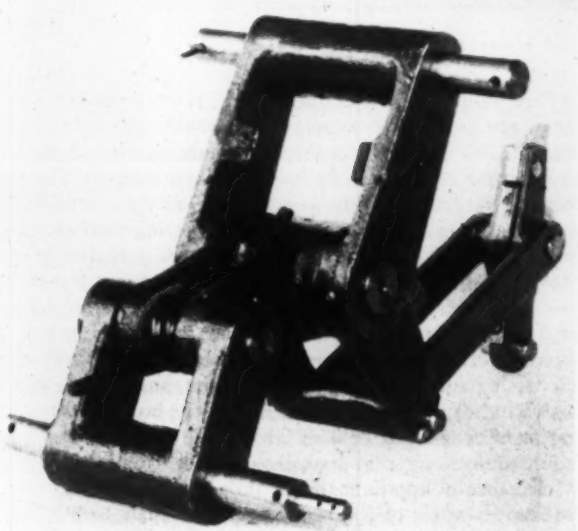


FIG. 7 SOLENOID-MECHANISM LINKAGE USING BRONZE PINS IN CAST STEEL AND MALLEABLE CAST IRON

with centerless-ground stainless-steel shafts, as illustrated in Fig. 8, this material has proved superior to metallic bearings in the following ways:

1 Its coefficient of friction is appreciably lower than most metallic bearings; moreover, the coefficient of friction decreases as the load on the bearing increases which makes it particularly desirable for heavily loaded bearings.

2 Its low modulus of elasticity enables it to absorb extremely high impact loads without cracking or permanent deformation.

3 Its flexibility permits it to distribute stress over the entire bearing surface even with minor misalignments in the bearing seats.

4 Its ability to absorb lubricant into the surface of the material reduces the frequency of maintenance for lubrication.

The linkage in Fig. 8 is shown schematically in Fig. 9 to illustrate how the operating forces act through the mechanism and bearings. The heavy arrows show the loadings, and the angles indicate the limited motion mentioned earlier. Fig. 10

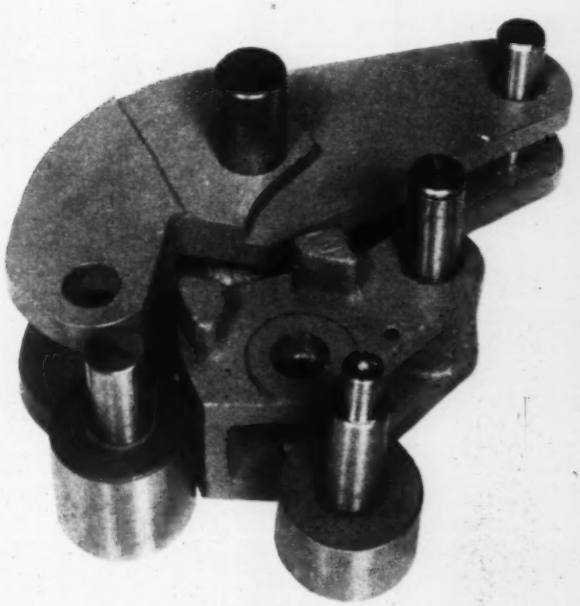


FIG. 8 CRANKS AND ROLLERS FROM AN AIR MECHANISM SHOWING USE OF TEXTOLITE BUSHINGS AND STAINLESS-STEEL PINS

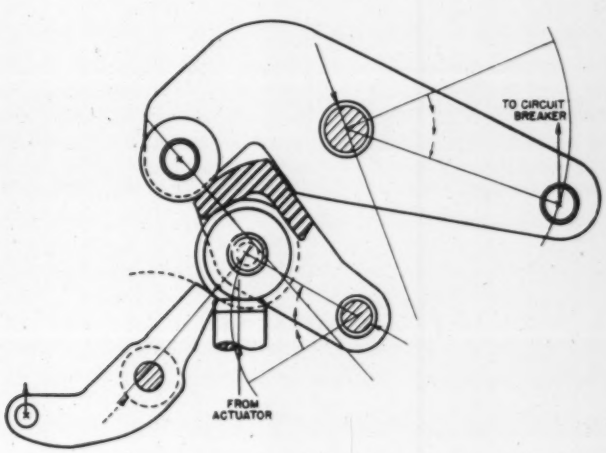


FIG. 9 SCHEMATIC MECHANISM ILLUSTRATING LOADINGS WITH HEAVY ARROWS AND LIMITED MOTION BY ANGLES

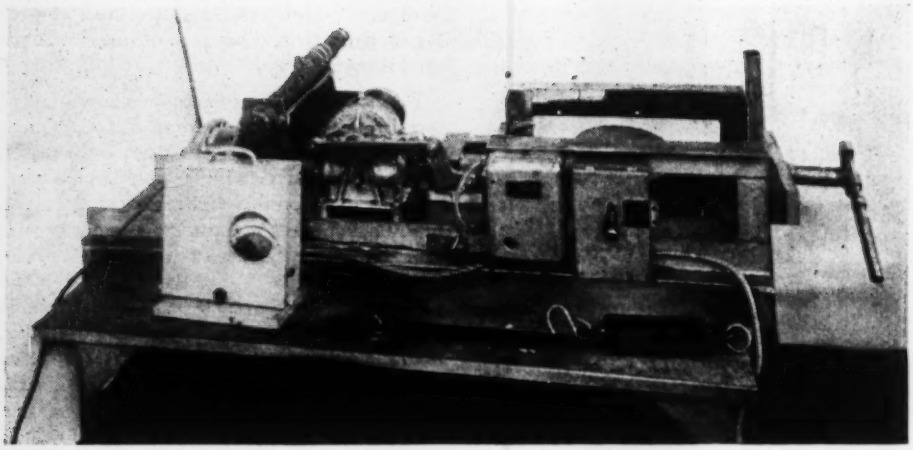


FIG. 10 BEARING TEST MACHINE FOR LIFE TEST AND FRICTION MEASUREMENTS

FIG. 11 TESTING FOR SHAFT BENDING AND BEARING LOADING IN OLSEN TEST MACHINE

shows the test machine used to compare textolite bearings with metallic and other nonmetallic bearing materials. In this machine any desired bearing load may be obtained. The shaft operates in each direction similar to a circuit breaker being closed and opened and then stands at rest 13 sec before the next operation. This allows four operations per minute. Fig. 11 shows an Olsen test machine and compressometer checking the shaft bending and the distribution of bearing loading. Fig. 12 is a close-up view of the bearing mountings in the Olsen test machine.

APPLICATION OF TEXTOLITE BEARINGS

The advantages which textolite bearings offer over metallic bearings for circuit-breaker applications have caused them to be used widely during the past few years for all locations except trip latches or other locations where very low torques are available. Ball, roller, or needle bearings have been used for these locations because of their lower coefficient of friction at lighter loads.

Textolite bearings are normally held in place by the press fit between the outside diameter of the textolite and the diameter of the hole in the supporting member. As textolite is a compressible material, considerably more interference between these two diameters can be tolerated than with metallic bearings. A textolite bearing, as much as 20 mils per in. of bearing diameter larger than the hole in the supporting member, may be pressed into place without damage to the textolite bearing, providing sufficient pressure is available. As it is pressed into place, however, the compression decreases the internal diameter of the bearing approximately the same number of mils as the interference between its outside diameter and the hole in the supporting member. Consequently the amount of press fit between the outside of the bearing and the hole in the supporting member must be held to fairly close tolerance in order to insure uniform internal diameter in the bearing when in place. A clearance of approximately 7 mils is desirable between the internal diameter of the bearing and the shaft to provide for shaft deflection between the two ends of the bearing and also to permit slight expansion during periods of high humidity. The wall thickness is $\frac{1}{8}$ in. for small and medium-sized bearings,

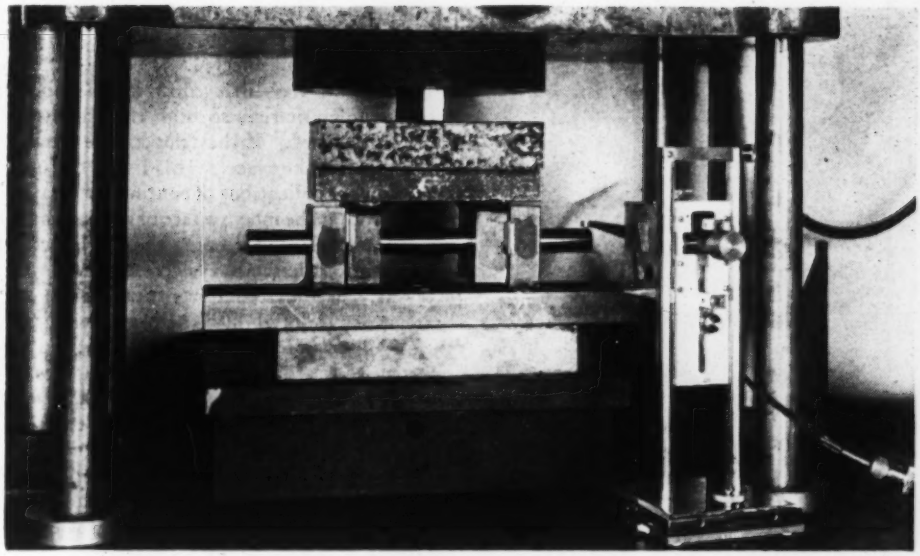
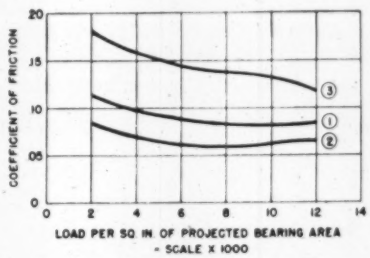


FIG. 12 BEARING MOUNTING IN OLSEN TEST MACHINE
(Compressometer tracing shaft displacement under load.)

while a $^3/_{16}$-in. wall thickness is used on the larger ones.

The coefficient of friction between the shaft and the bearing depends upon the amount of press fit which was used when inserting the bearing in the supporting member. Fig. 13



(1) Bushing interference fit 3 to 6 mils
(2) Bushing interference fit 8 to 11 mils
(3) Bushing interference fit 13 to 16 mils

FIG. 13 FRICTION-LOAD CURVES WITH STAINLESS-STEEL PINS ON TEXTOLITE BUSHINGS

shows curves taken on $^3/_4$-in. bearings with three different amounts of press fit, and with the same grade of lubricant in each case; No. 1 with 3 to 6 mils, No. 2 with 8 to 11 mils, and No. 3 with 13 to 16 mils. In No. 1 where only 3 to 6 mils were used, it was found that the shaft sank into the bearing and made contact with considerably more than 120 deg of its surface. In No. 2 with 8 to 11 mils press fit, the textolite was considerably more compressed, thus giving better support, and contact was made over 90 to 120 deg of surface, which decreased the coefficient of friction appreciably for all loads. In No. 3, with 13 to 16 mils press fit, less than 90 deg of contact was obtained and the coefficient of friction was almost doubled. This substantiates a large number of tests indicating that 8 to 11 mils of press fit per inch of bearing diameter provides the optimum operating conditions for circuit-breaker bearings. Therefore textolite bearings with this press fit may be used for most circuit-breaker applications.

Fig. 14 shows the method of installation of these bearings. The hole in the supporting member should of course be smooth with a small chamfer on the side from which the bearing is to be pressed into place. This is necessary to prevent damage to

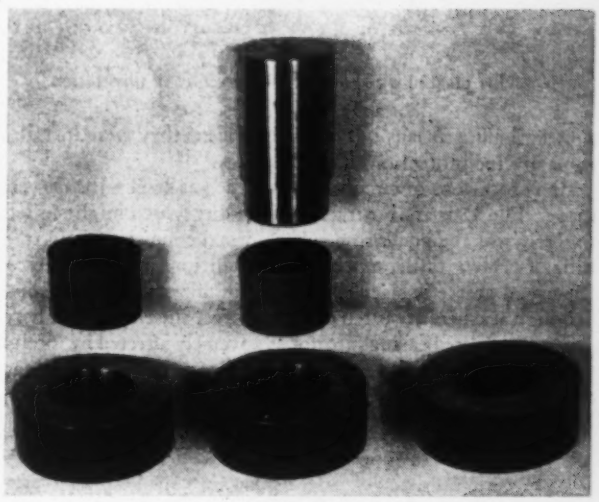


FIG. 14 TEXTOLITE BUSHING ASSEMBLY

the outer surface of the bearing during pressing into place. A small bevel at the ends of the outer surface of the bearings has also been found helpful in eliminating shearing damage during the pressing operation. In most cases the friction of the press fit will hold the bearing in place. If very short bearings are used, or if the impact loading is especially severe, it may be necessary to install retaining plates at either end of the bearing to prevent it from working out.

Life tests in actual circuit-breaker bearings show also that considerably higher bearing loads per square inch of projected area are permissible with textolite bearings than with metallic bearings. Whereas, 7000 to 8000 psi of projected area is considered maximum for most metallic bearings, 10,000 to 12,000 psi may be used without difficulty on textolite bearings. This permits the use of smaller shaft sizes, thereby resulting in further reduction in friction and faster breaker operating times. Textolite bearings may also be subjected to impact load which in a few operations would elongate metallic bearings beyond further possible use. This is particularly desirable in circuit-breaker applications, as it eliminates the necessity of dashpots

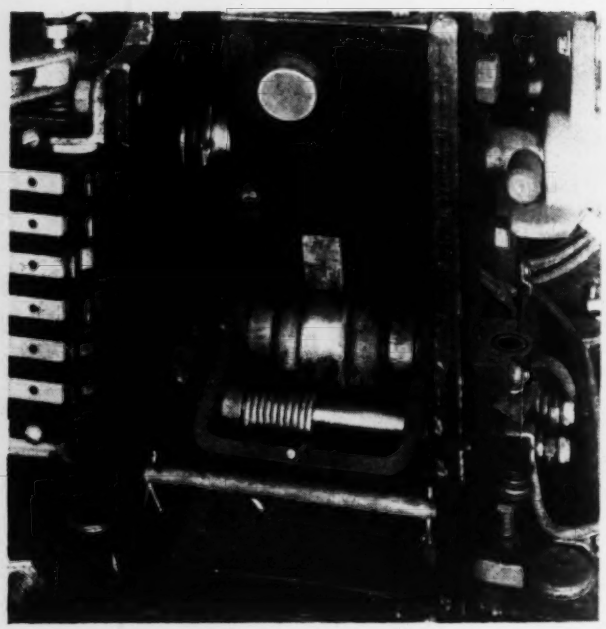


FIG. 15 TRIP LINKAGE OF A TYPICAL CIRCUIT BREAKER IN DIRTY LOCATION

(Note dirt piled along left-hand link in center of illustration.)

or other buffing means in many locations if they were installed primarily for protection of the bearings.

Many locations of circuit breakers such as steel mills are very dirty. Fig. 15 is an illustration of the dirt which might collect on a trip linkage under somewhat normal conditions. In steel mills or cement mills, much worse conditions are encountered. The use of grease in sleeve bearings minimizes the effect of dust although washers are often used to protect the ends of the bearings. Textolite bearings are not as adversely affected by foreign matter which may enter the bearing as are metallic bearings. Any foreign matter is embedded rather easily in the textolite and the scoring action on the shafts is greatly reduced. The bearing itself is not affected.

Temperature has little effect on the operation of textolite bearings unless it rises so high that the strength of the cotton fibers is impaired. If the temperature is raised higher, actual charring will take place. This limits the use of textolite bearings in most applications of continuous rotation where the local temperature at the inner surface of the bearing may be quite high, unless some means of keeping the bearing cool is provided.[2]

Lubrication has always presented a problem in circuit breakers. Without complete rotation and continuous rotation little grease is drawn into the bearing as it operates, therefore the only lubrication that can be depended upon is that which is inserted at assembly. Textolite bearings are made from a cloth embedded in phenolic resin. The spaces in the cloth are seldom entirely filled with the resin on the inner surfaces. The little pockets which are left retain grease much more readily than smooth metal-finished surfaces. This appears to explain to a great extent why textolite bearings operate so satisfactorily under the very heavy loadings on power circuit breakers.

CONCLUSIONS

The rather unique requirements for circuit-breaker operation have resulted in a type of bearing investigation somewhat different from that undertaken by industry in general. It is hoped that the experience outlined in this paper may stimulate interest in this type of application.

The textolite bearing has given very dependable service on intermittent operation under heavy loads. Friction is less than for other types of bushing bearings. Resistance to impact is remarkable on account of its low modulus of elasticity or springiness. Corrosion is practically nonexistent when used with stainless-steel shafts, and the lubrication problem is eased. All of which simplifies the maintenance problems and insures dependable operation of power circuit breakers.

[2] "Laminated Plastic Bearings for Heavy Duty and Severe Service," by E. P. Littlefield, *Product Engineering*, vol. 20, No. 1, 1949, pp. 111-115.

Petrochemical Industry

THE heavy reliance of the world chemical industries on petrochemicals will create a revolution in the international demand and supply situation for industrial chemicals, it was pointed out by Dr. Robert S. Aries, consulting engineer, New York, N. Y., in a statement on the future of the world's petrochemical industry to the Fuels and Energy Section Meeting, during the United Nations' Scientific Conference on the Conservation and Utilization of Resources, Lake Success, N. Y.

At present, one third of the chemicals produced in the United States are based on petroleum or natural gas. In contrast, less than 3 per cent of the world chemical production is now based on such sources, the position in which the United States was approximately two decades ago. The trend, however, is distinctly in favor of petrochemicals. A large number of other countries are now installing petroleum chemical units, most of them being designed in the United States. Thus large-scale production and potential exports can be expected from Great Britain (where two large units were recently started and two more are under construction), Canada, Sweden, France, Belgium, Italy, and Spain. In addition, several other countries, including Mexico and Israel, are seriously considering the possibility of putting up petrochemical installations.

Since the United States is expected to be a petroleum importing nation, the cost of petroleum for chemicals will not be less than the cost in most of the other countries which are not importers, and may even be higher than in the oil-producing countries, due to the absence of transportation costs. Thus the United States chemical industry is not expected to enjoy world markets in the future to the same extent that it does at present, as it will neither have a cheaper raw-material supply, nor better technology. In fact, some of the latest oil-cracking and conversion improvements are being incorporated in the ultra-modern plants abroad.

Such a basic economic shift for petrochemicals should make an interesting study of the interrelationship of resources and technology. It may even be conceivable that with low tariffs, Europe may not only export chemicals to the rest of the world, but even to the United States, because of the lower cost of some of the other components of the price of chemicals, such as labor.

The ROAD AHEAD *in* ENGINEERING

By J. R. VAN PELT

BATTELLE MEMORIAL INSTITUTE, COLUMBUS, OHIO

THE idea that engineering is changing is obvious when we think about it, but perhaps it has not received enough attention. For instance, how often, in engineering textbooks, do we find references to changing practice? The student spends most of his time in college learning about the profession as it exists today—or perhaps as it existed yesterday. Rarely does the author of a textbook mention the distressing fact that what he is presenting as the latest practice at the time he wrote the book, may be outdated a few years after the engineer graduates.

Even if we agree that many engineering innovations are being made today, we might be misled into imagining that such progress is only temporary. All the evidence, however, points to continued change for a long time to come—much longer than any of us will live. In fact, the rate of change is accelerating; the curve of progress is getting steeper. What we know about matter and energy is impressive, certainly. In the last few generations, it has produced a far-reaching revolution in nearly every phase of human life. But we have only scratched the surface in our mastery of Nature. There are strong indications that what we have yet to discover and apply is vastly greater than what we already know and use. We may as well make up our minds, therefore, that technology will not stand still, but will change before our eyes—not superficially, but profoundly; not occasionally, but constantly—and as long as we all live.

It seems fitting, therefore, that students of engineering should lay aside now and then the assignments and problems of the day, and should survey the long road which engineering has thus far traveled and will continue to travel in the future.

Our interest is to survey the road ahead. But, as we all know, a surveyor extends his traverse by taking first a backsight and then a foresight. Similarly, we need to begin by taking a backsight on the road already traveled by the engineering profession. For this purpose, I suggest that we review a well-known chapter of technology—the evolution of the reciprocating steam engine; for perhaps nothing else illustrates more clearly the rate of technologic advance.

THE STEAM ENGINE AS AN EXAMPLE OF PROGRESS

It was in 1712 that Thomas Newcomen, after prolonged experiments, first succeeded in pumping water out of the wet coal mines of England by his so-called atmospheric engine in which a single-acting cylinder served alternately as steam cylinder and condenser. This great invention of the first successful steam engine, perhaps more than any other single event, marks the beginning of the engineering era. By present standards, the Newcomen engine was pathetically inefficient. It generated steam practically at atmospheric pressure, and depended for its power on the partial vacuum which resulted when a jet of cold water entered the cylinder and condensed the steam. Unfortunately, the jet also cooled the cylinder walls, which then had to be reheated by the steam entering on the next stroke. But primitive as it was, the Newcomen engine was spectacularly successful compared with the horse-driven pumps previously used. Many of Newcomen's slow and clumsy engines were built. They saved the coal industry in England, and thereby hastened the growth of the factory system. They were so successful that 53 years elapsed before anyone succeeded in making any basic improvement in their design. Then in 1765 it suddenly dawned on James Watt, a young instrument maker in the University of Glasgow, that the wasteful cooling and reheating of the cylinder walls on every stroke could be avoided by connecting the hot steam cylinder to a cool condensing chamber, into which the steam would be drawn by vacuum. Thus was born James Watt's first contribution to steam-engine design—the separate condenser.

JAMES WATT'S CONTRIBUTIONS

But so far, Watt's device was only a dream. Ten more years were to pass before actual production of the improved engine could begin. In the interval Watt continued his experiments and took out his first patent which covered the separate condenser and the steam-jacketed cylinder. Finally, in 1775, when Watt formed his famous partnership with Matthew Boulton, the engine was put on the market. But what a time lag! Among the thousands of men who had come into contact with Newcomen engines in 63 years, only one, James Watt, had discerned the chief cause of its inefficiency and had been able to find a better design.

Now, at last, progress came—and came with a rush. The Boulton and Watt firm promptly began to build engines. Almost overnight the Newcomen design was obsolete. Further improvements followed rapidly. In 1781 the Watt engine, formerly limited to producing reciprocating motion for pumps, was adapted to deliver rotary motion for mill power. The next year Watt patented the principle of early steam cutoff, and also invented the double-acting cylinder. The latter, in turn, led to William Murdock's invention of the D-slide valve in 1799. Soon thereafter, Richard Trevithick in England and Oliver Evans in the United States began using higher steam pressures. This trend away from the low pressures used by Watt not only brought improved efficiency in the existing single-expansion engines, but also led to the adoption of compounding from 1804 onward. In 1849 the American, George Corliss, invented the Corliss valve gear which combined rapid closing of inlet valves with variable cutoff under the control of the governor.

Contrast, if you will, the two periods we have discussed. In the 63 years before Watt, the Newcomen engine had undergone no basic change of design and its duty,[1] or pumping per-

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[1] Duty was expressed in terms of pounds of water raised 1 ft by the consumption of a somewhat variable weight of coal—either a bushel of 84 or 94 lb, or a hundredweight: "A Short History of the Steam Engine," by H. W. Dickinson, Cambridge University Press, London, England, 1939, pp. 62, 87, and 101.

formance, never exceeded 12,500,000. In the 74-year period from Watt to Corliss, at least a dozen basic improvements in design were made, and the duty skyrocketed to nearly 150,000,000—a twelvefold increase in efficiency. The "curve of progress" was painfully flat in the earlier period, but steep in the later.

But with the development of the Corliss valve gear the design of reciprocating steam engines seemed to reach a plateau beyond which little remained to be done. True, pressures continued to increase, and many refinements of design were made, but the basic design was frozen. The uniflow principle was introduced later and offered somewhat greater efficiency through improved thermal gradients; but it was not adopted universally partly because of design limitations and partly because about this time all eyes turned from the reciprocating engine to the steam turbine.

I have reviewed the well-known evolution of the reciprocating steam engine because it illustrates a common pattern of progress. In its early history the development was slow. It then gathered momentum as thousands of men focused their attention on the problem of improving the design and increasing the efficiency of the device. Eventually the efficiency reached a point beyond which further major improvement could not be expected, at least under conditions that seemed practical at the time.

At this point it would be easy to make a fatal error in our reasoning. The plateau of high efficiency to which the steam engine has climbed marks the limit of improvement only so long as the original conditions still hold. We have only to change those conditions in some essential way and again the road is open for further advance. For example, it might be profitable to consider the substitution of some other liquid for water—a liquid possessing more suitable thermal properties. As is well known, the efficiency of any heat engine is limited by the range of heat availability of the working medium. Until recently, water has been the obvious and natural material to use for power generation in a cycle dependent on successive vaporization and condensation. Today, however, with a virtually unlimited range of synthetic liquids either already known or subject to formulation in the near future, there seems to be no compelling reason why their use as substitutes for water in steam engines may not be restudied profitably.

THE GENERALIZED CURVE OF PROGRESS

A history of this type might be shown graphically as a generalized "curve of progress." If we plot efficiency or state of development as ordinates against time as abscissas, the curve may rise slowly at first, then become much steeper, and then flatten out as a high level of efficiency is reached. It will remain on that plateau until some new and unconventional approach clears the way for further progress.

During the period of rapid development—when the curve is steep—it is fairly safe to predict continued improvement. But when efficiency is high and evolution is slow, it is by no means safe to assert that the development has come to an end. At any time some new process, new material, or newly discovered principle may unleash a powerful chain reaction of technologic development.

A NEW ERA FOR THE SCIENCE OF PHYSICS

Even whole branches of science have been the subject of such unsafe and erroneous predictions. As recently as 20 or 30 years ago, the science of physics had appeared to many men to have run its course. In the preceding century or two the physicists had discovered and fitted together nearly all the obvious laws governing gross matter and energy. The principles of classical mechanics were well understood; a large number of mechanical movements and linkages had been described and neatly classified. Conceptions of heat, light, and sound had reached a useful and reasonably well-rounded status. Even electricity in its simpler forms had been harnessed efficiently though admittedly not understood. At that time it was not uncommon to hear men refer to physics as a branch of science that was virtually completed. But what a surprise lay in store for these men of little faith!

Even as they spoke a Compton, a Niels Bohr, or a Millikan could have been found quietly exploring the still unanswered questions of the ultimate nature of matter and energy—problems which seemed academic to many. True, the problems were academic—in the best sense. By that I mean that they were based on the most rigorous of theoretical reasoning. But the dramatic application of their theoretical work in atomic bombs, and the development of peacetime uses of nuclear energy of which as yet we have had only an inkling, provide us with the best possible answer to those so-called "practical" men who placed a low value on pure theory. Physics, described only a few years ago as a virtually completed science, turns out to be as rapidly growing, as fruitful a field of human thought as any in our generation. And in referring to physics, I include its counterparts in engineering.

CHEMISTRY'S PLACE ON THE CURVE OF PROGRESS

There are of course strong competitors for the high place which I have given to physics. Chemistry and its applications constitute a field as large as physics, perhaps larger, both in the number of scientists and engineers employed, and in the range of industries served. What is the position of chemistry, basic and applied, on the curve of progress? Is it now in the early period where the curve is nearly flat, or is it in the mid-section where the steep slope shows fast growth, or on a plateau, such as physics occupied a few decades ago?

To generalize about any subject as broad as chemistry is difficult. Some branches of chemistry are well established, others are barely started. But let us try to visualize the subject as a whole. Chemistry and chemical engineering deal with combinations of the 92 chemical elements from hydrogen to uranium—to say nothing of the transuranium group. These elements combine in molecules which range all the way from simple pairs of atoms, on up to complex organic aggregations with molecular weights up in the hundreds of millions. We have only scratched the surface in the synthesis of possible compounds, the determination of their properties and behavior, and their application, through engineering, to human needs. The chemists and chemical engineers have ahead of them an almost unlimited field which they are attacking with a vigor and effectiveness which promises great developments for many years to come.

Let us turn from chemistry to a related field, that of metallurgy. This branch of technology includes both process metallurgy and physical metallurgy. The former deals with such operations as smelting and refining—the recovery of metal from ore; and the latter with the structure, properties, and uses of metals and alloys.

CAN THE BLAST FURNACE BE IMPROVED?

In the field of process metallurgy, perhaps we may examine with profit that old reliable, the iron blast furnace. By present standards, the blast furnace is an efficient device. Its by-products, including its waste heat, are put to use in so far as possible. It is a continuous rather than a batch process, usually being interrupted only when some part of the plant, like the

refractory lining, needs to be repaired or replaced. It utilizes the principle of countercurrent flow of materials. It is built in large units which keep down the operating costs per ton of iron produced. Like the reciprocating steam engine, therefore, it is on a plateau of high performance; and it might be inferred that the improvement of the blast furnace is mostly behind us. But when we say that its efficiency is high, we must make many assumptions. Two of these are that it operates at blast pressures only slightly above atmospheric, and that the blast consists of air with only the normal percentage of oxygen. If these assumptions can be discarded, the road may be open for further progress in blast-furnace efficiency.

Such ideas are not by any means the irresponsible imaginings of some popular writer. They are samples of the advanced thinking within the steel industry itself. The first of these assumptions is, in fact, already under attack. Five blast furnaces in this country have been converted to higher top pressures, thereby nearly doubling the weight of air in the stack at any one time. The steel industry is watching these furnaces with great interest.

The use of oxygen to enrich the blast is not yet a reality in this country. Its general adoption for this purpose must await lower-cost oxygen, and perhaps also the redesign of the blast furnace itself. But the possibility exists, not only to enrich the blast with oxygen, but also to control its humidity. The purpose of the blast is to provide specific material in the correct amounts for a certain chemical process. Why should we not control its quality as fully as we control the raw materials in other chemical reactions in industry?

Last January Dr. James B. Austin, director of research for the United States Steel Corporation of Delaware, spoke on the future of the steel industry.[2] He discussed all of the blast-furnace improvements that I have mentioned and gave many other glimpses into our metallurgical future. After outlining the near-term prospects, he ventured a more distant view. Let me quote a paragraph or two, describing a future steel plant very different from any now existing.

"Looking toward the very distant and hazy horizon, one must depend entirely upon imagination, with inevitably a strong flavor of wishful thinking. What one sees may be simply a mirage, a delusion; but glancing to this horizon in the direction of the steel industry, I see faintly, and in no detail, something like this.

"Iron is smelted in a blast furnace which is fed continuously streams of concentrated sized ore, flux of uniform size, and coke of uniform properties produced in a continuous coking oven. This blast furnace is quite different from what we have today. Its lines and size are different; it operates at high pressure with an enriched and conditioned blast. Molten iron flows from the hearth continuously along a trough through the bottom of which air is blown to refine the iron to steel. The steel then passes on to a basin in which its composition is adjusted, after which it travels on to one of a variety of curious-looking machines. One casts the steel into a continuous strip. Another casts a billet or rod which is then extruded into any desired shape, perhaps a pipe, a rail, or a beam. A third forces molten steel through a perforated plate not unlike the spinarets used for making nonmetallic fibers. These fine wires then go on to other apparatus where they are coated or otherwise treated. Is all this pure fantasy? Perhaps."

Perhaps, however, Dr. Austin's "fantasy" represents no greater advance over present steelmaking than the progress which actually has occurred in a few decades from the early wireless of Marconi to today's radar and television, or from the first man-carrying flight by the Wright brothers to our present air transport.

[2] "Horizons in Metallurgy," by J. B. Austin, an address delivered at Ohio State University, January 24, 1949.

TITANIUM, "METAL OF THE FUTURE"

From steel, the largest and one of the oldest metallurgical industries, let us turn to one of the youngest—titanium. This metal, long known but thus far not important commercially, has caught the imagination not only of engineers, but of businessmen and the general public as well. We need not go to the extreme of calling it "the metal of the future" or "the wonder metal." The bare facts are impressive enough. Titanium ores are accessible and abundant. Its alloys are strong and fairly light, so that their strength-weight ratio makes them suitable for airplane construction and other specialized engineering uses. In addition, their corrosion resistance and ductility are high. Until now, the commercial utilization of titanium has been delayed because of the high cost and technical difficulties involved in recovering the pure metal from its ores. These problems, however, are moving rapidly toward solution. When they are solved, engineers will have at their disposal a new family of materials of construction, with a unique combination of properties.

A few years ago a process metallurgist would hardly have thought of himself as a fuel producer. Fuels meant, to all of us, coal, petroleum, natural gas, and their products. Now comes the prospect of nuclear power plants, and the fuel turns out to be metallic. So we have the interesting situation of metallurgists producing metals to be used as energy sources, and serving side by side with physicists, chemists, and almost every kind of engineer on the team that is exploring the field of nuclear energy. Here is another of tomorrow's engineering frontiers.

CONTROLLING PROPERTIES OF METALS BY PHYSICAL METALLURGY

Since every engineer is vitally concerned with the properties of metals and their alloys, perhaps I may be permitted to pass now to the subject of physical metallurgy. Here the possibilities for the future are fully as bright as in process metallurgy—perhaps brighter. For several decades past, metals and systems of alloys have been studied to determine their physical and chemical properties. When a metal or alloy was needed for some new use, such data enabled the metallurgist to specify which of all known materials would be most suitable. The data also gave the metallurgist some insight into the relation between the structure of the alloy and its properties. Little by little these glimpses of fundamental relationships have been fitted together like the pieces of a jigsaw puzzle, until now some parts of the picture are beginning to emerge. No longer is it necessary merely to observe and measure the properties of an alloy; it is becoming increasingly possible to predict those properties. As a result, metallurgical specifications are changing. Instead of calling for an alloy of such and such composition, there is a growing tendency to specify such and such properties, regardless of composition. The physical metallurgist then creates an alloy which possesses the desired properties. He does this not by tedious trial and error so much as by a process of prediction. The predictions are based on general principles accumulated by metallurgical research. Needless to say, the predictions are as yet imperfect, and must be checked in the laboratory. The laboratory checks often lead to still more bits of knowledge which, in their turn, fit into the jigsaw puzzle.

An example of this kind of metallurgical work may be illuminating. Some years ago the Elgin National Watch Company

decided that a better mainspring for watches was needed. The springs then in use throughout the watch industry were made of carbon steel. They were good when new, but after many windings they tended to lose their elasticity, so that the watch had to be wound more often. In addition, they could readily become magnetized, resulting in poor timekeeping. And they would rust, causing stress concentrations and breakage. With these problems in mind, specifications for a better mainspring were drawn up. They called for a spring which would retain good elastic properties in service, which was nonmagnetic, and which would not corrode. The firm asked Battelle Institute to develop such an alloy.

For a dozen years Battelle engineers worked on this problem. The result was Elgiloy, an alloy of eight metals, which meets the requirements with marked success. To have tackled the problem by trying alloys of eight metals on a mere cut-and-try basis would have been foolhardy. Many millions of such combinations would be possible. To make and test them would take centuries. But by applying to this problem the general laws governing the behavior of metals as alloy components, it was possible to arrive at the answer by a reasonably direct route.

In the next half-century, the time during which the students of today will be practicing engineering, many such innovations will be witnessed. In fact, it is certain that they will directly affect the careers of those who follow the engineering professions. The future engineer will be called on to specify the desired properties, to create the material, or to put it to some engineering use. The field is practically unlimited.

PROVINCE OF THE CERAMICS ENGINEER

However, our keen interest in metals should not blind us to nonmetallic materials—the province of ceramic engineers. From time immemorial the ceramic industry has been centered around such products as brick, tile, glass, pottery, and porcelain. The manufacture of these materials was more an art than a science. Today, however, ceramic engineers are blazing new trails. The old familiar ceramic products are being studied scientifically and improved, and new ceramic materials are being created to meet exacting engineering requirements.

Examples of these engineering uses can be found in modern airplane power plants—in the combustion chambers of jet engines, in rocket chambers and nozzles, as well as in gas-turbine parts. Material for such purposes must retain its strength and shape at high temperatures, and must resist the corrosive attack of the combustion gases. Much progress is being made in developing ceramic materials suitable for these uses.

Among their limitations, however, have been the relatively low tensile strength and the lack of ductility of ceramic bodies. The strength and ductility of many metals led to the idea of trying composite materials, consisting of ceramic compounds in a metallic matrix. These composites are being investigated with some promise of success.

Here, in these composites, two separate branches of engineering—metallurgy and ceramics—join forces to explore their mutual boundary. Teamwork of this kind, in the no man's land between two technologic fields, is proving to be extraordinarily fertile.

TEAMWORK IN SCIENCE AND ENGINEERING

Many other examples could be cited. One such is the cooperation of geologists and physicists in developing geophysical prospecting techniques, whereby the discovery of petroleum has been so greatly accelerated. From experiences of this kind we are justified in making a generalization of far-reaching significance, namely, that many future engineering developments will grow out of studies in the borderlands between different sciences or engineering branches. Though a student may be specializing in chemical engineering, for example, he may find himself a member of a team, serving beside a physicist or a mechanical engineer on a problem which could not be solved by one profession alone, but which yields readily to such a combined attack.

RESEARCH, THE KEY TO PROGRESS

Throughout the foregoing, the emphasis has been on change. What is the mechanism that brings these changes about? That question can be answered in a single word—research. Without research, technology would be as static as classical Latin and Greek. Fortunately, research has come in recent years to be recognized so widely that no longer is it a field for a few. It has become a major field for engineers as well as basic scientists. Dean Hugh S. Taylor of Princeton recently quoted a passage written by an eminent French scientist, Père Teilhard de Chardin, which I should like to repeat here. Concerning the development of research, he said, as translated by Dean Taylor.[3]

"From the first awakening of reflective consciousness, man surely has been possessed by the spirit of research. Until quite recently, however, this profound need remained, in the mass of humanity, latent, diffused, or unorganized. In each generation, in the past, the true research workers, seekers by vocation or profession, have been recognized. But they have been only a handful of individuals, generally isolated, rather of an abnormal type—the group of 'curious men.' Today, however, without our having paid particular attention to it, the situation is completely changed. By hundreds of thousands, at this moment, men in all directions of thought, life, and matter, are undertaking research, no longer alone, but by organized groups, endowed with a power of penetration that nothing seems to be able to arrest. Here also, the movement is in process of becoming generalized, it accelerates, to such an extent that one would have to be blind not to see in it an essential element. Manifestly, research, today still a luxury occupation, is in process of becoming a primary function, even a principal function of humanity. What does this great event signify?"

Research "by hundreds of thousands . . . no longer alone but by organized groups, endowed"—by teamwork—"with a power of penetration that nothing seems to be able to arrest." Research, once the occupation of only a handful of people, is today "in process of becoming . . . a principal function of humanity." That is the picture which I want to impress on my readers. As engineers, they may follow the more technical phases of our profession, or may become factory managers or business executives; but regardless of which of these two roads they elect to traverse, each is destined to be either a research man or a partner of research men. It is to these men of research that we must look for the technologic progress which will maintain the forward momentum of engineering and industry.

If the student is so minded, research offers a fascinating occupation for an engineer; but if design, operation, or sales comes closer to his interests, then at least he will recognize the research man as his brother-in-arms in the endless battle for the material progress which underlies our social fabric. It will be understood that like the operating engineer, he is performing an essential function, and that it is he who is building the road ahead, over which all engineers, indeed all the western world, will travel.

[3] "Research—A Human Resource," by H. S. Taylor, an address delivered at Ohio State University, November 4, 1948.

Under-Car Engine-Driven POWER PLANTS *for* RAILROAD PASSENGER CARS

By D. R. MacLEOD

LOCOMOTIVE AND CAR EQUIPMENT DIVISIONS, GENERAL ELECTRIC COMPANY, ERIE, PA. MEMBER ASME

HISTORY OF DEVELOPMENT

THE battery-and-axle-driven generator power-supply system has been standard on passenger cars in this country since the introduction of electric lighting. The addition of air conditioning 20 years ago was made possible only by extending the capacity of this inefficient and expensive combination. The cooling load in summer, improvements in lighting, and introduction of electric cooking and, more recently, the consideration of electric space heating have combined to step up power requirements until today they sometimes exceed 50 kw per car. To supply such loads, battery sizes, ranging from 1200 amp-hr at 32 volts to 450 amp-hr at 114 volts are used with axle-driven motor generator sets that put out 40–50 kw (1).[1] Receptacles with capacities up to 35 kva have been provided for alternating-current power to drive the generators in yards and terminals, in order to take over the load and bring the batteries up to charge. Battery manufacturers have improved their product to stand the high rates of charge and discharge common in this service; but even now railroad passenger-car batteries, in many cases, have a life of only 3 years.

The axle-driven generator requires approximately 2 engine hp from the locomotive for every kilowatt it generates. The portion of the locomotive capacity used in this way costs and weighs approximately 5 times as much as the generator itself. The total weight of the power-supply equipment on a modern coach and its portion of locomotive weight is approximately 20,000 lb. The cost of maintaining this portion of the locomotive is several times that of the axle generator. Maintenance costs of batteries differ widely.

About 15 years ago the author's company began to seek methods of improving this situation. Head-end power (2), in which Diesel-engine-driven alternators in a power car supplied power to the entire train by means of power lines, was considered. One installation made over 10 years ago is still in operation. Recently this plan has again been studied (3, 4). It has the basic limitations that all cars must be wired for the system and that, when the train is separated for any reason, power is lost on all cars beyond the break.

In the late 1930's installations were made, on an experimental basis, of Diesel-engine-driven alternators mounted under the car (5) but no large-scale applications followed. At that time the small Diesel engine was not sufficiently reliable for passenger-car power supply unless backed up by large expensive batteries.

A large number of Diesel-engine-driven alternators, rated at less than 50 kw, performed successfully during the war. Near the close of hostilities a program was started for the development of an independent power supply for passenger cars. This included testing under simulated service conditions, and later, consignments of experimental equipments to interested railroads. A practical system has been devised for the parallel operation of the sets on individual cars in a train. This includes a simple scheme of paralleling by making or breaking the electric coupler sockets at the time the cars are coupled or uncoupled. No special knowledge is required of the "car-knockers" to do this work, and no complicated synchronizing devices are used. By proper consideration of all the engineering problems, an alternator-exciter-regulator system was devised which permitted the simplest form of control. Servicing of the equipment was given special consideration in the mechanical design (1). A heat-recovery system also has been formulated and reduced to practice by at least one of the car-heating companies.

BASIC DESIGN FACTORS AND UNITS OF SYSTEM

Certain basic engineering factors must be considered in the design of an engine-driven under-car alternator. Railroad engineers should understand these so that some measure of standardization can be worked out by the Association of American Railroads. It is only by early standardization that the railroads will obtain maximum flexibility in operation and low costs.

Clearance Requirements. The size of the power plant which can be installed under a car is determined very largely by the equipment clearance line permitted by the railroads; to allow margins of safety from known obstructions, and to allow for wear and movement of parts in rounding curves. The height of the obstacle, plus the margin of safety allowed for clearance, plus the allowance for vertical wear and car movement give the total height that the bottom of any equipment on the car must be kept above the top of the rail when the car is new. Similar allowance must be made for worn-flange play, journal-box play in the pedestal, movement of the center plate, and movement of the swing bolster in a swing-bolster truck. To this must be added the offset of the car, at the point where the equipment is mounted, when it is on the curve where the worst lateral interference is found.

In Fig. 1 *KABCDE* shows the equipment line which is a composite of the requirements of a number of railroads, with the equipment mounted at a selected point between the truck centers. This is not a standard equipment line, and is included only to illustrate the problem. This line was established for a point which had a total lateral movement of $14^{5}/_{8}$ in. from the center line of the track, and a total vertical movement of 5 in. allowed for wear and clearance requirements. The line *ABCDE*

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

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FIG. 1. EQUIPMENT LINE FOR POSTWAR NEW CARS WITH $14^5/_8$ IN. TOTAL OFFSET FROM CENTER LINE OF TRACK DUE TO MAXIMUM CURVATURE PLUS LATERAL MOVEMENT

moves upward for greater allowances for wear, margin over obstacles, and so forth. The line *BCD* moves to the right for sharper curvature, more allowance for lateral movement, and for mounting closer to the transverse center of the car.

The height of the center and side sills, and the width of the cars built since World War II vary considerably. In numerous cases the bottom of the center sill is only 24 in. above the rail. Line *KLMNOP* was made up as a composite of all these cars, taking the limiting dimensions in each case. The result of this study indicates that the over-all height of under-car equipment, located at the outside of the car, cannot exceed $26^3/_8$ in. More vertical space is available toward the center line of the car. In the older cars the center sills are higher above the rail, but there is less room between the center sills and the car sides. Thus on postwar cars, the over-all depth of the equipment at the level of the center sill may be 47 in., but on many prewar cars it is slightly less.

The over-all length of any single piece of equipment is limited by the location of needle beams and, on roomette cars, the location of hoppers, etc.

Selection of Engine. There are very few engines now on the market, of a size suitable for vertical mounting under the car, that can be rated at 40–50 hp continuous output for railroad application. A few horizontal engines suitable for this purpose have been developed. The relative advantages of the two types can be evaluated only by experience with a large number of units. A displacement of 250–300 cu in. is required in an 1800-rpm engine for an output of approximately 30 kw in railroad service, if the four-stroke cycle is used. With a two-cycle engine a smaller displacement may be used. Since the volume of the engine-generator set for a given output varies inversely with the speed, it is desirable to use a high-speed engine.

Governors. The fuel-pump injector-and-governor assembly constitutes a large part of the small Diesel-engine cost. To insure a fair division of load between engine-driven alternators operating in parallel, speed droop is desirable. The average mechanical governor (6) is designed for about 3 per cent droop from no load to full load. This is insufficient for under-car power plants because variations in setting are bound to occur under railroad maintenance conditions. Governors should be set as close together as possible at no load—a speed equivalent to 62 cycles is suggested as standard for the AAR, as this is the upper limit of frequency variation for standard power-consuming devices. If no-load conditions exist on an entire train, which is improbable, some power exchange is to be expected unless preventive control is provided. Experience will show whether this control is necessary.

Governor damping is necessary to prevent hunting. Its form will differ with the type of governor used. This supplements the electrical damping provided by the alternator to maintain over-all system stability.

Temperature Control. Factory tests indicate that an engine-alternator set should not carry more than about half load until it is warmed up to approximately 50 F. The temperature differential from inlet to outlet jacket water should be held at about 10 deg F under continuous operating conditions. The engine should be shut down if the jacket water approaches the boiling point.

Engine Air and Exhaust. Engine air should be as clean as practical. If it is taken from the interior of the car, approximately 7 sq in. of duct area will be required. If it is taken from under the car, some form of air cleaner should be provided to supplement the conventional oil-bath filter, as the air will contain large amounts of dirt and brake-shoe dust.

The exhaust back pressure should not exceed about 3 in. of mercury. The muffler requires approximately 1.3 in., leaving some 1.7 in. for the piping. This is important when the exhaust gases are carried up through the roof of the car. Stainless-steel tubing should be used because of the corrosive action of the exhaust.

Noise. This is a problem in vibration engineering (7). Engine-air intakes in the car will cause noise that it is difficult to reduce below the threshold normal ambient noise with the car at rest. When exhaust is carried up through the car body, ducts must be designed to reduce noise to a minimum (8). The principal source of noise is vibration, transmitted from the engine to the car body. The set must be isolated from the car by rubber-in-shear (9), designed for the low-frequency pulsations of an engine. A set in one location may cause more noise inside the car than it would in another location. Roomette cars present a special problem because of the openings into the car in the vicinity of the engine. Modern coach construction effectively isolates air-borne noise.

Fuel Tank. Fuel-tank capacity will depend on the interval between fuelings. Assuming a 50 per cent load factor, the engine will consume approximately 2 gph. Sufficient fuel should be provided to insure against its exhaustion; otherwise the fuel pump has to be primed before the engine can be restarted, and some fouling of the injectors will occur. An alternator in a paralleled group will operate as a synchronous motor when the fuel of its engine is exhausted. A small engine may consume as much as 1 gal of fuel per hr at light load. Continuous engine operation at no load will result in fouling of the fuel injectors. "False-brinelling" (10) of the bearings may occur if the alternator does not rotate for long periods while the car is in motion. Experience will indicate which is the more serious consideration.

Battery Capacity. Approximately 500 amperes at about 20 volts are required to start the set at temperatures in the neighborhood of zero. Approximately 350 amperes at 22 volts are required at 32 F. This indicates a 150-amp-hr 16-cell lead battery, or a higher-amp-hr-rated nickel-iron alkali battery.

Excitation System. Successful car-lighting equipment must preclude objectionable flicker of the lights. Fluorescent lamps

are not as much affected by sudden dips as are incandescent lamps, particularly if the voltage and frequency vary together. Dips of more than 15 per cent below minimum rated lamp voltage may cause starter-equipped fluorescent lamps which have just been switched on to go out. Larger dips of short duration can be tolerated if the lamps are warm. This problem is not as severe with instant-start ballasts. Time is a very important factor. If the flicker recurs every few seconds, only a fraction of a per cent voltage variation can be tolerated. Such variations are liable to occur on incandescent lamps due to engine pulsations. Mechanical and electrical characteristics of the alternator must be such as to prevent objectionable dips in voltage when large induction motors are started across the line, or two 30-kw alternators are paralleled when 180 deg out of phase.

These requirements necessitate an ultra high-speed excitation system. The development of the amplidyne made it practical to get the precise control necessary for such a system.

The amplidyne (11) has an exceedingly short time delay. These characteristics make it ideally suited for engine-driven alternators. It requires only about 1 w to control its entire output and therefore uses a static regulator of small dimensions.[2]

Alternator. The dimensions of under-car alternators are determined by excitation requirements rather than by heating. With a vertical engine, the diameter of the alternator may become the limiting dimension in a power plant. Therefore a small-diameter alternator is an advantage, if it can be obtained without sacrificing desirable electrical characteristics. The alternator, when operating alone, must be able to start a 15-hp air-conditioning compressor motor without objectionable flicker of the lights.

Parallel operation requires the addition of a pole-face winding to the alternator field. This serves to reduce hunting and maintain stable operation. It also provides additional torque for pulling the machine up to speed when the alternator is paralleled out of phase and below synchronous speed. Its principal disadvantage (aside from cost) is that the short-circuit currents of the alternator are increased. Hence it is desirable to use the minimum amount of pole-face (amortisseur) winding required to give successful parallel operation.[2]

Mechanical construction is very important. Armature windings must be braced to withstand the forces produced by the high currents which sometimes occur during synchronizing. All windings must be treated with several coats of water and dirt-resistant varnish. The same general practice should be used for the construction of these alternators as is used for axle-driven generators. Care must be taken to avoid exposure of vulnerable parts of the engine and other equipment for flying ballast, brake shoes, and the like.

Heating. An under-car power plant provides a good source of heat for hot water and space heat. The average car requires approximately 170,000 Btu per hr for space heating. For hot water, passenger cars require up to 50,000 Btu per hr, and diners up to 80,000 Btu per hr. A good upper figure is 250,000 Btu per hr, and in extreme climates, 350,000 Btu. A 30-kw engine alternator has available the heat equivalent of approximately 90 kw, divided about equally between jacket water exhaust gases, and electrical output. This is sufficient for the majority of cars, while still leaving enough power for lights, ventilating fans, and refrigeration. However, in case of engine failure, some other source of heat must be made available. Since it is desirable to have steam heat for stand-by operation, an efficient combination consists of a common heat exchanger into which the engine jacket water is fed directly. The output of a heat exchanger in the exhaust, electric immersion heaters, and the output of a heat exchanger in the steam line provide the remainder of the heat. Since the engine jacket-water temperature is held at 180 F, this leads to a 180 F heating system. Such a system permits the locomotive train-heating boilers to be shut down during most of the year.

Engine Pulsations. Engine-alternator design must consider the power pulsations which can occur in parallel operation. The torque of an engine will have pulsations above and below the average due to the firing of the cylinders (12). Resonance occurs when the torque that is making the alternator swing is in step with the natural frequency of the alternator and prime mover. In a properly balanced engine, the torque-pulsation frequency will be the same as the revolution per minute for a two-cycle engine and equal to half the revolutions for a four-cycle engine. Harmonics of the fundamental also will be present in the torque pulsation. Any unbalance between cylinders, such as that caused by fouled injectors, will increase the magnitude of the pulsations. Reasonable allowance for this must be made in the design.

In the usual case it is sufficient to determine the natural period of each of the engine-driven alternators acting alone, and to make sure that the frequencies of the disturbing forces fall outside the band given by the highest and lowest frequency.[2]

Negative Damping. There is a critical limiting value of resistance in the armature circuit of an alternator of the type used in the under-car power plant, beyond which cumulative hunting may occur. When this occurs at no load, it can usually be stopped by additional amortisseur effect. The severity of hunting increases as the excitation is increased. Therefore an adverse regulator characteristic may contribute to the severity of this phenomena under certain conditions.[2]

Short Circuits. High values of alternating torque are developed on sudden short circuit (13). These short-circuit torques are experienced when single-phase short circuits occur on an engine-driven alternator operating alone, or in parallel with other alternators.[2]

Synchronizing. In stationary power plants, the frequency of an incoming alternator is brought very close to that of the bus, and the line switch is closed when the two voltages are nearly in phase. Equipments are available for automatic synchronizing. They are not necessary with under-car power plants, and their use is to be avoided because they represent additional control devices to maintain. It is necessary, therefore, to design for the transient torques generated when the incoming machine is paralleled when out of phase with and differing in speed from the bus.

When a single alternator is paralleled on a hit-or-miss basis, the electrical transient torques may be worse than the short-circuit torques previously described. They are usually not appreciable if the speeds are relatively close and the electrical angle between the incoming machine and the bus is on the order of 30 deg or less. The lower the reactance of the alternator, the smaller the angle at which the electrical torques become appreciable.

Tests on small under-car power plants show that the minimum over-all disturbance is obtained when paralleling by applying the field before closing the line contactor. The disturbance is violent if the paralleling occurs when the incoming machine is 180 deg out of phase, but of much shorter duration when the paralleling is done with the field fully excited than when it is done with the machine unexcited. It has also been found that with proper design it is practical to parallel a machine with the bus when its speed is as much as 10 per cent slow.

It is recognized that critical speeds may exist at speeds below normal, and that the engine has to go through these criticals in

[2] Additional details are given in a Mathematical Appendix which is available upon application in writing to the author.

coming up to speed (14). Generally this is not serious because the set will pass through the critical speed before the vibrations have time to build up. Out-of-step operation is not likely to occur under normal conditions because the reactance between machines is relatively low and because the fuel limit on the governor tends to unload an overloaded generator. It is of course possible for the paralleled group of alternators to become overloaded and fall below rated speed.[2]

Load Division. If two alternators are paralleled, their characteristics are such that any small difference in voltage will be equalized by the flow of leading or lagging current. These currents have a cumulative effect and will build up to large values unless precautions are taken to prevent the occurrence by "cross-compensating" the voltage regulators. A resistance is inserted in the connection of the potential coil of the regulator to the two phase-wires. A current transformer in the third phase-wire is connected across the resistor so that zero power-factor lagging or leading current adds directly to or subtracts directly from the phase voltage. This "fools" the regulator into believing that the voltage is high or low as the case may be and it adjusts the excitation accordingly. The connection of the current transformer across the resistance is such that increasing the resistance causes the current to come more nearly into phase with the voltage. This compensates for inequalities in the regulator settings and for the pulsations in voltage due to engine operation, and divides the reactive load equitably between the machines. Changing the voltage of one machine in a group operating in parallel can only change the division of the reactive current. The division of real power is determined by the engine governors. These are selected to give a drooping characteristic so that the speed falls as the load increases. A 5–6 per cent droop is desirable to secure a reasonable division of real power unless an excessive number of speed-control devices are used. Attempts should be made to set the no-load speed of all governors the same and depend on the slope of the characteristic to keep the division of load reasonably close when the individual slopes are different.

The droop in the governor and the biasing of the regulator (cross-compensation) introduce voltage and frequency variations which are not necessary when the engine-driven alternator operates alone. Commercial induction motors are guaranteed for a ±5 per cent variation in frequency and a ±5 per cent variation in voltage, or a total of ±10 per cent variation in both frequency and voltage combined. Similar variations are permissible in other devices, but care should be taken that the resultant voltage limits are suitable for all devices.

Control. A number of different schemes are available for securing automatic paralleling of alternators in the train when cars are cut in or out. In general, the greater the number of control wires used, the less complicated the scheme becomes. It is possible to use only two wires. A great step in simplification can be made if three wires are used, and further simplification is possible with more wires. The basic requirements are that, when one group of cars is coupled to another, one of the groups is broken up into single, or at the most two, alternator units in such a way that power is left available on each car. The units are paralleled one at a time to keep the rush of current through the contactors to a minimum. The control wires should be in the same receptacle as the power terminals so that when the power circuits are to be separated at the receptacle, suitable line contactors remove power before the circuit is broken at the power plug.

Dummy receptacles must be provided for the plugs that are not coupled to another car, and these can be used to form terminating circuits indicating the two ends of the train. Eventually some system of paralleling control will have to be standardized for all manufacturers so that there will be complete interchangeability of cars between trains and even between different railroads. The simpler the control schemes are, the easier it will be to standardize them.

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EMPLOYEE *and* COMMUNITY RELATIONS

By H. L. R. EMMET

WORKS MANAGER, ERIE WORKS, GENERAL ELECTRIC COMPANY, ERIE, PA. MEMBER ASME

I HAVE been asked to discuss the question of employee and community relations. Since the healthiness of our community relations is so largely dependent on the success with which we manage our employee relations, you will find that this paper deals very largely, in fact almost exclusively, with employee relations.

The question of employee relations was an old subject of human discussion when the Pyramids of Egypt were built. Our children's children will go at it with the same zest, piety, sanctimony, and righteous indignation that we do and that our fathers did before us. The relations of men with men stir deep feelings in us as we all so well know.

For all of these reasons it is difficult to avoid being entirely platitudinous in what I am going to say. As a matter of fact it must be admitted that about all that can be said on this subject has been often said before. If you find anything in what I have to say that contains a trace of originality, I'll indeed be happy.

However, there are a few things I do sincerely want to say about this question as I come to the end of a long career[1] during which I have found it of first interest and importance.

It may be that in years to come our ability to deal with the question sensibly and successfully will prove to be our salvation as a free society of the kind we have known and cherish so dearly.

If this is true, and I suspect it is, then the question must be of such great importance to us and our future generations that we should certainly not hesitate to now deal with it most frankly and boldly.

If we are to prove ourselves as successful factory managers, and surely we want to do just that, is there a single simple characteristic about our factory, always assuming a good up-to-date physical plant, which it is most desirable for us to attain? I believe there is and I believe it to be simply—the spontaneous co-operation of the men and women who do our work. That is the priceless pearl we seek.

To gain it we must dive deep in the sea of sociological fact and history having stripped ourselves of those encumbering passions that so universally seem to assail us whenever the so-familiar human characteristics of greed and covetousness are aroused.

We all know there are multitudes of things we must do as managers if our people are to have confidence enough in us to give us their spontaneous co-operation. Of this multitude of things, those I'm going to discuss are but three. My experience tells me that they are the three things about which there perhaps exists the greatest amount of misinformation and misunderstanding in American factories and factory communities. The three of them are as follows:

(1) Always dealing with every individual employee with complete justice; (2) our attitude toward the trade-union question at factory level; lastly, and perhaps the most difficult of all, (3) the question of informing our employees about our business activities and about their and our relation to them.

INDUSTRIAL JUSTICE

So first let's consider the question of industrial justice. For years it has been my privilege to have had close association with working people and to have dealt with them on many subjects. At the risk of appearing oversentimental toward old associates, I must, nevertheless, assert that the general decency, reasonableness, and intelligence of our American workmen is as nearly beyond reproach as are such qualities in any large group of people anywhere. They can't be fooled and we shouldn't attempt such folly as to try it. They will fight—blindly sometimes—and they shouldn't have to fight their managements. Give them but half an explanation and they'll give you back full measure and more besides. Before such a condition can be realized, however, management must itself conform to a proper code of ethics toward its people. It must discipline itself to stand by that code at all times, never ignoring the democratic tradition to which we are born and bred and which must, therefore, deeply affect the thought and impulse of all employees.

In this particular connection management has perhaps dealt with the hopes and demands of its people too much on a basis of expedience, too little on a basis of principle. We so eternally drive ourselves to accomplish that which is desired technologically that we often fail even to consider what simple principle should be followed in dealing with this most important consideration.

Should we now feel it wise to search for such a principle, let us first remember that the modus operandi of our body politic is based on recognition and protection of the rights of the individual. Such is our democratic process. Perhaps, then, we may conclude that a proper principle upon which to conduct ourselves is that of "justice to each individual employee."

Some may consider such a very simple principle hardly worthy of the respect my experience has taught me to attach to it. It seems that mankind is often likely to overlook or even scorn the simplest and best things merely because they are so simple. Such appears to have been the case even in the days of Naaman, Captain of the host of the King of Syria, about whom we read in the Old Testament. Naaman was a great man and a successful general, but he was a leper. Hearing there was a prophet in Samaria who could cure him, he journeyed there and came to the prophet Elisha. Elisha told him simply to wash himself in the River Jordan that he might be cured. This was entirely too simple a process for Naaman and he went away in a rage, declaring there were just as good rivers to wash in at home. But his people said to him, "My father, if the prophet had bid thee do some great thing, wouldest thou not have done it? How much rather then, when he saith to thee, 'Wash, and be clean.'" So Naaman washed himself in the Jordan, "and his flesh came again like unto the flesh of a little child, and he was clean."

[1] Mr. Emmet retired from active service on Oct. 1, 1949.

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I fear a policy of expedience does not answer today. It seems to encourage in us too much sham and smartness; too little simple direct dealing, easily understandable; the kind of dealing that leaves our minds fresh and clear even as was Naaman's flesh after his simple bath in the Jordan. Basing our reasoning and actions on the principle of justice to each individual employee is a horse of another color and I can recommend it.

But it is easy to deal in high-sounding phrases; another matter to live up to them. Therefore let us consider how we can effectually adhere to this principle in practice, granted we have decided upon its adoption in ordering our relations with employees.

Assuming reasonably safe and adequate working quarters and equipment, we will perhaps agree that our men are most interested in three things, job security, wages, and opportunity for advancement. Without indulging in exact detail, we know it to be a fact that complete techniques are available for determining the proper elements of all jobs on the scale between the simplest and the most highly skilled. Excellent methods have been developed for determining the correct market price for any type of craftsmanship in any community at any time. Employee-rating techniques have also been developed through which it is not difficult to determine which individuals should be laid off or rehired strictly in accordance with their individual seniority and ability. In like manner, those individuals who first deserve an opportunity for advancement are readily ascertainable. Is it really possible to deal justly with each employee in the absence of some such practices?

In the past we have, perhaps, been too prone to leave these three vital matters generally in the hands of our foremen. We know that these men alone, able and honest though they may be, cannot possibly carry out such assignments with the exactitude their importance merits in addition to their many other duties. Therefore the development of the techniques, particularly in large factories, is purely a job for specialists. After they have done the development work, the foremen will find difficulty enough in making proper application, even with the constant aid of the specialists whom we know as planners, time-study men, and personnel men.

Perhaps the simplest of these tasks is periodically to survey existing community wage rates. A good man can be relied upon adequately to obtain the necessary data after the first few surveys. When it comes to developing job elements with all the charts and formulas incident thereto, or the development of an individual-ability rating procedure with its varying conceptions of standards, we must assume that we face a job extending over several years.

The proper introduction of these procedures does not only involve their development and application, since that is probably the simplest part of the process. They must be well understood not only by the supervisory force but also by the men themselves and particularly by their responsible union heads. If they fail to understand and have faith in them, the whole endeavor becomes of questionable value, particularly since considerable expense is involved. We must learn to constantly explain and discuss, and demonstrate and explain again. We must satisfy ourselves that these quite complicated procedures are thoroughly intelligible to the many employees affected by them.

THE LABOR-UNION QUESTION

When we come to the labor-union question, this brief discussion attempts to deal with it only as experienced within the individual factory itself, where only one or a few union locals may be involved. The question of the international unions themselves, with all their ramifications, political, monopolistic, and otherwise, is beyond the scope of my present purpose. Suffice it to say that their influence, whether it be political, financial, or of some other variety, will, in all probability, be subject to the will of their membership and the general public, tempered by the quality of leadership displayed.

Such must be the history of any large organization of men in a free country such as ours. No special interest can too long conduct itself in a manner detrimental to the best interest of the general public, be it either a great corporation or a great international union. Enlightened leadership always becomes aware of that fact and will not long persevere in any such effort. Where checks and balances are necessary, they will eventually be provided either voluntarily or by statute. It seems we've been witnessing just such a process during the past few years.

So now let us ask ourselves whether the trade union is an appropriate and necessary agency in our free industrial community. When we read the history of early industry in England and our own country, and with frank conscience probe even our own memories for the past half century, we find that there certainly was very great necessity for some kind of organized employee representation to protect workers from most serious exploitation, and to promote the protective legislation in many directions with which we are now familiar and of which we today highly approve.

It appears that because of the nature of its property rights management possesses tremendous authority and power within its factories. Such authority may well be greater than even the best of us are competent to administer with unfailing justice at all times and under all conditions as well, as in the case of each individual employee.

We must remember that adequate checks and balances are invariably imposed by statute on those entrusted with equivalent power in our governmental system. There must have been good reasons developed through our history for this state of affairs.

Here again it seems that even the best of men have exploited their fellows in the absence of definite curbs, when great power was entrusted to them. Such exploitation may not often be intentional but results rather from the carelessness that great and unchecked power seems to inspire in about all of us.

The interposition of a property line or a factory fence does indicate the limits of private ownership but it surely does not seem to change man's nature.

And so most of us may agree that this vast authority bestowed upon us managers by the nature of our property rights is, in fact, very much in need of substantial checks and balances. Then what should the nature of these be and how should they be arrived at?

King John had some pointed suggestions made to him when the Magna Charta was presented to him at Runnymede. It seems that management had a somewhat similar experience when Labor's Magna Charta, the Wagner Act, with all its imperfections, was presented to us. Neither we nor King John were enthusiastic. Nevertheless, it seems that the underlying reasons which stimulated both measures were much the same. The Magna Charta has certainly stood the test of time. The great code of English law has been developed with it as a foundation. I presume we are now witnessing the gradual development of good labor legislation in much the same manner.

So in our time the trade union appears to be the most available and appropriate agency so far discovered to represent the interests of industrial employees and to provide a workable balance on management's power. It is here and here to stay—no doubt about that.

Since such is the case, then what should we do about it? Should we merely strictly follow the law on the subject as it is interpreted for us by our lawyers and let it go at that? Should

we, in our self-righteous indignation at the troubles that often very inexperienced or downright dishonest union leaders bring upon us, hate and despise the union of our employees and everything about it? Should we, in other words, confuse the principle of unionism with bad union leadership?

Or should we remember that the union is our employees' only safeguard against exploitation and whether the leadership of it be good or bad, our people will fight for it if we attack it, sneer at it, and scorn it? Isn't it true that if our men and women have faith that we sincerely believe in the principle of trade unionism and truly want their union to be the best there is, they will ultimately see to it that worthy representatives are selected to carry on the union's business in the shape of the best available stewards, officers, and committees?

Perhaps we should also remember that we, the owners and rightful wielders of great authority, should properly make the first concessions by sincere realization and acknowledgment of these latter considerations.

INFORMING THE EMPLOYEES

And now we come to our third and perhaps most important of the three subjects that were mentioned earlier. It is about the question of adequately informing our employees about our business activities and about their and our relation to them as well as about any other subject of interest to them and to us.

A factory—particularly a large one—is a community in itself. Furthermore, because of our hiring procedures and methods of selecting the best that apply for our jobs, this community must be a very high-grade kind of a community. With this fact in mind, the principle I want to enunciate is that if we can find ways and means of so informing these high-grade people so they can have a reasonably clear understanding of why management does what it does and fails to do what it does not do, then our labor-relations problem as well as our community-relations problem may well be far on the road toward reasonable solution.

These employees of far better than average intelligence and responsibility are sure to generally agree with about all of our opinions of what we as management should or should not do and what they as employees should or should not do, if we can only find ways and means of informing them, as we must inform ourselves, about the whys and wherefores. The difficulty is to develop practicable methods for doing the informing.

It is all simple enough where only a few employees are concerned. When there are many hundreds and so often many thousands in single factories, then the job becomes a formidable one.

I would like to make a few observations of some methods that I have seen used with some success.

Of course we find ourselves restricted to but a few possible methods—the spoken word, the written word, and moving pictures which are, I suppose, a combination of both.

The oldest of these methods is of course the spoken word and I suspect it is still by far the best one.

In the large factory—at times close to 20,000 employees—of which I have been the manager for more than twenty years, we have had some interesting experiences in our very sincere efforts to inform our people. We have used all three of the methods mentioned but have convinced ourselves that regular meetings, at least monthly, with not more than 12 to 30 employees—the fewer the better—around a table, away from their work stations, and lasting from one to two hours, constitutes by far the best means of accomplishing this informative purpose.

Our first attempt along these lines was started many years ago. It consisted of monthly meetings held by the manager himself with about a dozen employees, all hourly workers, two from each of the six main sections of the plant. These meetings still continue, but the number of participants has more than doubled as the size of the plant has increased. Subjects discussed cover about everything under high heaven with the single exception of matters involved in the regular union grievance procedure. We look upon that as a truly sacred procedure and method of adjudicating the grievances of individual employees in their search for industrial justice. We do our best not to walk on the union's grass in that regard.

Informal minutes are worked up after the meeting and published in our plant publication so that all employees may read them. From the beginning we have had conclusive evidence that they do read them.

As this procedure was developing, all of our superintendents and department heads have held similar monthly meetings with their people.

Some years ago an added, and what has proved to be a most interesting feature of the Manager's Informative Meeting, has been our Rumor Clinic. Anybody can file a rumor on any subject, anonymously or not, directly with the manager and he will answer it. I believe the number of rumors I have answered during the past six or seven years must be nearly 1100. Many make exceedingly interesting reading. Of course there is a "gossip" quotient involved in this and the whole Erie community seems interested in it. Each month we take a full page in the local papers so that these rumors and answers, as well as the minutes of the Manager's Informative Meeting, can be published.

We have had the readership of this page scientifically surveyed. The local public's interest in it appears to be about equal to its interest in the headlines on the front page of our local newspapers. This was a novel phenomenon to the organization employed to make the survey, and quite extraordinary in their long experience.

As these procedures have been developed, I believe we have finally come to the ultimate means of accomplishing this informative purpose and it seems to be a very good means. This is the Foreman's Informative Meeting.

Our approximately 600 foremen and equivalents supervise from 12 to 25 employees apiece. Some years ago one of our superintendents decided to try out a scheme through which a few of his promising younger foremen took their people away from their work stations to an office and discussed with them whatever seemed appropriate for discussion. There was no dearth of subjects for discussion, as quickly became apparent.

It is interesting that, at first, these foremen felt quite nervous about sitting down in a quiet meeting room with their own people. Having done it once, they were invariably impatient to do it again and again.

After all, it wasn't very surprising that employees felt great interest in knowing about their job and their individual relationship to it. Our job is about the most important thing in our lives and in the lives of our dependents. The more an employee knows about his job, about the men who direct and supervise that job, and why they do the things they do, the more satisfied he appears to be that the bosses from the top to the bottom of the list have good reason for existence and are not the ogres they are often supposed to be. Furthermore, it is discovered that the boss may even be a "right guy" and worth doing a real job for.

By the same token the boss learns much by these discussions. Among other things he has much natural pressure put upon him to know all he can possibly know about his own job and about his responsibility as an individual manager of that job.

I can testify from much experience that the many questions

which employees ask at these meetings are searching ones, to say the least. They are the questions that should be asked and should be fully answered.

These Foreman's Informative Meetings are rapidly becoming universal practice in our factory. For that matter, informative meetings are already largely used in the case of engineering-department employees and other salaried groups. It seems that they have already contributed much toward that spontaneity of effort for which we factory people strive.

It is often amazing to realize how easily frank answers by management to searching questions by employees will entirely dispel impending trouble and promote the condition that Woodrow Wilson had in mind in 1918 when he so truly said that "the highest and best form of efficiency is the spontaneous co-operation of a free people."

In a factory that is what we are after—spontaneous co-operation—if we are to have any hope of a truly efficient and really stylish operation.

I suppose there exist and I have seen factories where spontaneity was conspicuous by its absence, and still a profitable operation was maintained, for the moment at any rate. I have always felt that such a factory was skating on thin ice. How much sounder and happier it is for all hands to work out their careers in a happy and enthusiastic factory community. How much more certainty must there be in such a factory about that profit consideration which is so vital to our industrial salvation.

WE MUST REVISE SOME OF OUR IDEAS

In finally reviewing our three subjects, we should perhaps conclude that during the present generation times have changed to such an extent that we must revise some of our ideas. We should think of labor not so much as a commodity that may, on occasion, be dragooned, but rather as composed of individual human beings to whom we owe clear explanation of our actions and policies. We must contrive to govern our industrial community with its self-made code of ethics more nearly along the general lines of our civil community with its democratic ideals and customs. Justice to individual employees must be our constant aim if we are to receive their confidence and the resulting spontaneity in their efforts to further the success of our mutual job.

Irrespective of the fact that we have no choice in the matter, because of the existing statute, we should sincerely concede the right of employees to self-organization. Some of us have already found that the existence of honestly conducted unions may well be an aid to shop efficiency rather than a detriment. We have found them indispensable in guaranteeing justice to every employee.

Human relations in industry are of such paramount importance and of such elusive nature that dealing with them on a basis of expedience alone is probably an inadequate and often a dangerous procedure. If we are fortunate enough to have gained some clear understanding of those simple things that guide the hearts and minds of men, we may properly select a simple principle for our guidance in resolving many of our problems. All men crave justice. The unit that our national tradition, as well as the State itself, is based upon is the individual. Therefore the principle of "justice to each individual employee" seems to recommend itself.

Having adopted such a principle, we discover that our best and perhaps our only available guarantee of ability to completely realize it in practice is with the help of honestly conducted unions of our employees, including sensibly and scrupulously maintained grievance procedures.

We must develop ways and means for adequately informing our people about their and our business with its many ramifications. If we can learn to do this effectively, we may feel confident that their innate intelligence will quickly stimulate them spontaneously to co-operate with us in performing our job efficiently and even stylishly.

Having successfully accomplished these basic necessities, we truly recognize our employees as individuals of importance. Therefore we may confidently depend on them, both in their hearts and by their actions, spontaneously to acknowledge that mutuality of interest with management so vital to the successful progress of industrial enterprise in our democratic commonwealth.

Labor-Management Relations

A SOUND national labor relations program is necessary for continued progress in American industry, Herman W. Steinkraus, president of the Chamber of Commerce of the United States, told the American Mining Congress, recently, at Spokane, Wash.

In looking ahead to establishment of sound relations between employer and employee, management, said Mr. Steinkraus, must give consideration and understanding to demands which stem from the human desire for security. These demands, Mr. Steinkraus listed as follows:

Everything possible must be done to level out the employment curve in individual plants as well as in the whole industrial machine. The drastic ups and downs in our economy must be leveled out. For only in this way can the further demands for a guaranteed annual wage be avoided. Leveling out the employment curve is not only good human practice but it is good business practice as well. Most enlightened people in labor, government, and management are convinced that human aspirations and business aspirations are completely dependent, one on the other, for successful fulfillment.

Profit sharing in some form has strong appeal as a second ingredient of security. The public seems convinced that programs embodying the principle of profit sharing are sound. Many companies have had a rich experience in this field. A study of their experiences could reward all companies. It could be another way of bringing labor and management more closely together as partners in business.

The desire for pensions is a third ingredient of security. Pensions, it should be remembered, are not new. Many companies have had pension plans for years; many other companies are now contemplating them. The principal of joint contribution to pension funds is a sound principle. It is recognized by Government in the Social Security Law. The question of whether employees should contribute toward pension plans should not be the basis for strikes now.

Progress, said the speaker, is being made toward establishment of a labor-relations program which will meet the tests of differing viewpoints in labor-management discussions. The refusal of Congress to repeal the Taft-Hartley Act is encouraging, he said.

Current threats of strikes, Mr. Steinkraus declared, should not blind the public to the fact that in thousands of plants, big and small, all over America, labor and management are working together in harmony.

STATISTICAL METHODS *and* QUALITY CONTROL[1]

By LOUIS C. YOUNG

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE public is constantly exposed to statistical data occurring in advertisements, in arguments, and in the distribution of information. If something is said to have been statistically proved, opposition is supposed to become quiescent. Everywhere the ordinary citizen needs some ability to distinguish between what is truth and what is falsehood."

Amplifying this statement in the first chapter of his book,[2] Dr. Johnson extends the same concept from the layman to the scientist and engineer. As he points out without delay, statistics as a science has made such rapid strides during the past thirty years that it has outgrown completely its popular definition—that of collection and interpretation of data. Not only has it invaded every branch of science in its modern form, but it has drastically revised many of the governmental methods of remaining alert to public thought and activity. Even the arts, the author points out, have started to employ statistical reasoning for several practical purposes.

STATISTICAL METHOD AS APPLIED CHIEFLY TO RESEARCH

With these ends in mind, the author has developed a thorough and intensive text on statistical method, as applied chiefly to research. Though his interest and examples are chiefly centered in the field of education, it requires no imagination to see that the material presented therein would be directly applicable to research in any branch of science or engineering.

Although the basic principles of probability and likelihood are stated in the second chapter and are thereafter used in the development of the many methods presented, a prior acquaintance with statistics will facilitate a better appreciation of the text. Explanations are in many cases inadequate for satisfactory comprehension of the method being demonstrated. References to original articles containing the complete exposition are, on the other hand, abundant. The text would be valuable as a guide of source material, if these were its only contents. In addition, the number of applications covered during the course of its three hundred odd pages will make it very convenient in recalling methods and formulas used infrequently.

The subject matter of the third to ninth chapters is too varied and comprehensive to enumerate in detail; but generally covers sampling distributions, significance tests of many statistics, point and interval estimation of population parameters, treatments of anormal data, and sampling theory and practice. The latter is discussed at some length, chiefly with regard to sampling of population, and the definitions and purpose are given of the several types of such samples.

The remainder of the book is devoted to analysis of variance and covariance, and closely related subjects, in application to research. The examples used for illustration are progressive in intensity, allowing a good comprehension of both the principles and procedures involved. For those engaged in technical research, this section is of particular value. The principles of experimental design are stated clearly and are correlated with the procedural explanation and examples which preceded them.

QUALITY CONTROL IN INDUSTRY

In "Quality Control in Industry,"[2] Mr. Rutherford presents a picture of the industrial quality-control organization: its purpose, its relationships to the manufacturing personnel, and its procedures. A partial objective of the book is set forth in the foreword by Dr. J. M. Juran: "The limiting factors in extending applications of Quality Control lie today not in any inadequacies of the overemphasized statistical methods: the limitations lie rather in managerial inertia; in general failure to comprehend the broad economics of quality control; in unbalanced know-how among quality-control engineers, skilled in use of techniques but unskilled in methods of getting them accepted."

For top management, the book should suffice for a large proportion of manufacturers of intermediate size: it would be particularly appropriate for those who supply others with parts and subassemblies and (possibly) raw materials. In the larger and more highly integrated companies, the text would serve best as a primer for quality-control foremen and their supervisors.

Throughout the first third of his work, the author describes the scope of the functions of a quality-control department, and explains how these are affected by the organizational structure of the manufacturing company. In this he is quite analytical, presenting in detail several alternative forms of structure and the advantages and shortcomings of each. The average student of quality control, lacking industrial experience, would find the discussion of straight-line, staff, and functional organizations of decided value for the light it throws on the possible weaknesses of quality-control operations.

Passing next to the economics and costs of quality control, Mr. Rutherford establishes the point that there must be in any factory some specific amount of control expense that will minimize total cost per unit of product. That this amount is not easily determined with precision should not prevent an attempt at approximation, and trial usage of a greater or less degree of control to determine possible savings in total costs. Unfortunately, he does not present any case example dealing with a farsighted and altruistic chief inspector who increases his own expenses in order to save the manufacturing department an even greater amount. This reviewer feels that such an example might forcefully demonstrate the disadvantages of some of the budgetary controls so commonly employed to make a departmental manager cut his own expenses to the detriment of those incurred in other departments. Unless added advisory personnel are used (at added expense) to promote that balance of expenses which yields minimum costs, the effect of periodic

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] A review of "Statistical Methods of Research," by Palmer O. Johnson, Prentice-Hall, New York, N. Y., 1949; and of "Quality Control in Industry," by John G. Rutherford, Pitman Publishing Corporation, New York, N. Y., 1948.

indexes of expense (e.g., quality-control expense per productive hour) is usually to reduce or destroy interdepartmental cooperation.

The discussion of control of quality departmental cost contains some pertinent and detailed remarks on job description and qualification, effective utilization of inspection personnel, and scheduling of man power on the basis of production schedules. Although these subjects are taken up in greater detail in texts on manufacturing practice, the latter seldom give special consideration to the quality-control function and personnel and to the many unusual problems peculiar to them.

Following two brief chapters on the training of personnel and the relationship of the quality-control group to other departments, the author ends his consideration of general principles (part 1) with a chapter considering the customer's representative. The occasional references to operations in the aircraft industry indicate some of the author's sources of information. In developing the topic of the customer's representative with specific attention to quality he mentions some of the difficulties which may be encountered in government contracts, and suggests remedies. With what may be regarded as restraint, he writes: "The scope and complexity of the problem is considerable. It is possible to operate smoothly with the customer representatives only after a considerable period of training and experience. Some trouble and misunderstanding may be expected in a plant contracting to the government for the first time." Mr. Rutherford then proceeds to describe some of the circumstances under which misunderstandings may occur and recommends ways of avoiding them.

DETAILED STATISTICAL METHODS OF CONTROLLING QUALITY

In the second part of his work the author details statistical methods of controlling quality. In general, these are presented simply and in case examples, with sufficient explanation of the technical background to demonstrate effectively the principle involved. The majority of the techniques which he describes and illustrates are those which have found extensive application in quality control.

The first of these chapters defines a few basic statistical terms and illustrates some of the more fundamental probability concepts and distributions. The next deals with sampling inspection, with chief reference to the Dodge-Romig tables and methods of single and double sampling. The author here presents a case involving a point which invites argument. He states that one of the shortcomings of 100 per cent inspection lies in the tedium of such work, and the resultant errors made by personnel required to do such inspection. He does not ascribe the same tedium and error to the inspection units, and the reader might be led to infer that the change from inspection of a sample of, say, one hundred units of one product to inspection of a sample of one hundred units of another type of product would relieve that tedium and thereby reduce the error. This would be true if such were the usual practice: Presumably this is the type of situation with which the author was concerned. In many cases of practice, however, an inspector completes inspection of a sample of one hundred units only to proceed with inspection of another and still another sample, of the same unit. The sample inspector who replaces ten 100 per cent inspectors and inspects only ten per cent of the units usually finds it no less tedious. Alternatively, furthermore some 100 per cent inspectors, who are given leeway in the scheduling of their duties, choose on their own initiative to switch from one item to another from time to time in order to avoid the tedium of constant repetition.

In dealing with process control, Mr. Rutherford explains the use of the control chart, and demonstrates the meaning and method by means of data pertaining to spot welding. The example is rich in description of the technical aspects of the problem of controlling spot-weld quality, and is detailed at sufficient length to allow a grasp of the reasons for the several steps.

The last chapters are concerned with specialized and practical applications of statistical methods, respectively. Mention and use of a factor of safety in one of the examples presented, raises a question with which the example is not directly concerned. In writing specifications for the destructive test of a sample of units, the engineer usually employs a factor of safety. To what extent and by what method does he set this factor to make it compatible with the manner of testing and number of units in the sample being tested? Presumably, the answer lies in joint specification by engineering and quality-control personnel, or by an engineer with statistical background.

THUS we see ourselves governed all through life by a higher power, whose nature we shall never be able to define from the viewpoint of exact science. Yet, no one who thinks can ignore it. A thinking human being, who has not only scientific but also metaphysical interests, must choose one of two possible attitudes: either fear and hostile resistance or reverence and trusting devotion. If we reflect on all the unspeakable suffering and incessant destruction of life and property which have plagued mankind since time immemorial, we may be tempted to agree with the pessimistic philosophers who consider life worthless and deny the possibility of permanent progress, of a betterment of mankind, and who profess instead that it is the fate of every human civilization to turn blindly against itself as soon as it reaches a certain peak, and to destroy itself without sense or purpose.

May exact science be cited as an evidence of such a far-reaching view? The answer must be "No," if for no other reason than because science is not qualified to decide the question. From the scientific point of view, one might just as well, and perhaps with even more justification, endorse the opposite opinion. It would require merely an extension of the range of observation, a thinking not in terms of centuries but of many millennia. Or is there anybody who would seriously deny that during the past one hundred thousand years *Homo sapiens* has made progress and has improved himself? Why should this progress not continue further—if not in a straight line, then at least in waves?

Of course, such considerations, such a long range view, are no help to the individual. They cannot bring him succor in his hour of need or cure his pain. The individual has no alternative but to fight bravely in the battle of life, and to bow in silent surrender to the will of a higher power which rules over him. For no man is born with a legal claim to happiness, success, and prosperity in life. We must therefore accept every favorable decision of providence, each single hour of happiness, as an unearned gift, one that imposes an obligation. The only thing that we may claim for our own with absolute assurance, the greatest good that no power in the world can take from us, and one that can give us more permanent happiness than anything else, is integrity of soul, which manifests itself in a conscientious performance of one's duty. And he whom good fortune has permitted to co-operate in the erection of the edifice of exact science will find his satisfaction and inner happiness, with our great German poet, in the knowledge that he has explored the explorable and quietly venerates the inexplorable. (Excerpt from chapter taken from the forthcoming book Scientific autobiography and other papers, by the late Max Plank, to be published by the Philosophical Library on October 17. *Science*, September 30, 1949.)

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Atomic-Energy Report

THE Sixth Semiannual Report of the Atomic Energy Commission, published in July, 1949, outlines briefly the major nuclear developments and gives the status of programs as they stood at the end of June, 1949.

The report reveals that new and more effective atomic weapons, which were tested at Eniwetok in 1948, are in production. Under the Commission's direction, components of these weapons are being produced on an industrial basis by competent manufacturing concerns or special Government facilities throughout the country. The Los Alamos Scientific Laboratory has developed into a vigorous, well-staffed research organization with a carefully conceived long-term program of weapon development.

Fissionable material is being produced in greater quantities than ever before. Substantial shipments of raw material from abroad were received; and domestic uranium-mining concerns are beginning to supply ore to newly activated processing plants. A research program is developing better ways of processing low-grade ores. A far-flung program of exploration is under way to locate new sources of supply.

The chain of chemical and metallurgical plants which convert raw uranium into feed materials for the uranium 235 and plutonium plants at Oak Ridge and Hanford are on a sound operating basis. Better processes have been developed; the health of workers has been further safeguarded; unit production costs have been reduced by nearly 30 per cent since 1947; and intermediate stock piles of materials have been built up to adequate levels.

The production of uranium 235 at Oak Ridge has been made more efficient by installation of new equipment and by better operating techniques in the gaseous-diffusion plant. The yield of uranium 235 from a given quantity of normal uranium has been increased, and the cost of this operation has been cut in half since 1947. Research in the process is scheduled to result in a new plant addition with even greater savings.

At the Hanford plutonium plant, repairs and improved operation have made it possible to defer $150 million in new reactor construction which 2 years ago seemed necessary. As part of a $450 million construction program, additional production facilities have been brought to the threshold of completion. More efficient use of present equipment is today producing 40 per cent more plutonium per dollar of operating cost than in 1947, and yield from a given amount of feed material has been increased.

Work in laboratories and research centers is showing progress toward more efficient utilization of uranium supplies, toward finding new materials suitable for construction and shielding of power reactors, and toward improving and developing materials required for military application of atomic energy. The national laboratories have been strengthened and expanded, and supplied with new facilities; scientific and technical personnel have increased; and the morale situation has recovered from a very low point. Unclassified research in nuclear physics and related sciences is supported in some 100 projects in more than 50 institutions. The distribution of radioisotopes for use in research has been greatly expanded. New isotopes and new chemical compounds containing isotopes are being made available domestically.

Reactor development is being carried forward on a broad front, with simultaneous attacks on problems of research in nuclear physics, health physics, chemistry, biochemistry, radiobiology, metallurgy; on problems of development and operation in chemical, electrical, mechanical, and civil engineering; and in the new and ever broadening field of nuclear engineering. The foundation being laid now for a sound atomic-energy program in the United States requires the training of men in all of these fields.

A major part of the work consists of applied research and developmental engineering problems dealing with new metals for structural purposes, shielding, and heat-transfer equipment. Considerable attention is being given to improvement in methods of separating unwanted fission products from reactor fuels and of processing waste for disposal.

During the period covered by the report, the following accelerators, being constructed for the Commission, went into operation:

The 300 Mev synchrotron in operation at Berkeley, Calif., has the largest capacitor bank in the world tied into its oscillating circuit. The bank consists of 3328 individual conden-

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

sers, used for the fleeting storage of electricity between the surges of current thrown into the magnet. It is triggered by four large "Ignitron" tubes that time the release of the power to the magnets. As an indication of the power used, each surge between capacitors and magnet transfers 105,000 joules of energy. This transfer occurs six times per second.

When its magnet is pulsed its attractive power has a maximum force of 60 tons.

The chamber in which the electrons are accelerated is highly evacuated by constant operation of two pumps.

This synchrotron was first operated in January, 1949, at its full 300-Mev energy capacity. The usual mode of operation is to hurl the accelerated electrons against a target of a heavy element. In this case, uranium was used. It produced high-energy x rays which then were used in nuclear experiments.

The x rays produced mesons, the first made by this process in a laboratory, and showers of ionized particles of lead plates. These showers, observed in a cloud chamber 85 ft from the synchrotron, are similar to those in cosmic-ray observations. The particles of cosmic rays have greater energies than any other known particles. Now an effect of the cosmic rays has been duplicated in the laboratory, and studies in cosmic rays can be pushed forward under controlled conditions.

This machine and others at the laboratory are also contributing to biological study. The 184-in. synchrocyclotron can be made to project 350-Mev protons into the air as a stream of parallel rays, which penetrate several inches deep into animal tissue. At the focus of the beam—up to $5^1/_2$ in. deep, and within a diameter as small as $^3/_8$ in.—the radiation effect is four or more times more powerful than at the surface. This may become important in the radiation treatment of such deep-lying tumors as those of the lung, bone, or brain. No other kind of radiation known achieves its greatest effect deep in the tissue, with much less damage on the surface. The dosage by conventional x ray, for example, hits hardest on the skin and falls off as the radiation penetrates into the body.

The quarter-scale model of the 110-ft accelerator to be built at the University of California is complete, and operational tests have started. A measurable circulating beam has been accelerated, thus proving the fundamental principles and design to be correct. As a result of the experience with synchrotron operation, designers are modifying plans for the full-scale machine, and may be able to reduce the quantity of steel used in the magnets by some 600 tons.

Scientists are running model tests of magnets for the 75-ft 2 to 3-Bev proton-synchrotron at Brookhaven National Laboratory, N. Y., and their findings are contributing to the design of magnet plates. Building excavations are complete, and the proton-synchrotron foundations were poured last fall to allow for settling. Equipment that requires a long delivery time is already on order.

The 184-in. cyclotron built by the University of California with private funds and now operated for the Commission is the largest now known to be in use and the one that first produced mesons. Designed originally to accelerate deuteron and alpha particles only, it has been modified to use proton bullets as well. With protons accelerated to 350 Mev, it has produced cosmic-ray nuclear particles, called mesons, which previously had been generated in cyclotrons only with the heavier alpha particles.

The Brookhaven National laboratory has ordered a 60-in. cyclotron, which will be used primarily for experiments in nuclear physics.

During predelivery tests, a 3.5-Mev Van de Graaff electrostatic generator ordered by Brookhaven reached the maximum energy required without difficulty.

During preliminary testing runs, the 5-Mev Van de Graaff at Argonne has operated successfully at energies of about 2.5 Mev. Maximum-energy tests are planned. This accelerator, like the one at Brookhaven, will be used to study the effect of radiation on materials.

The Los Alamos Scientific Laboratory has contracted for the delivery late this year of a Van de Graaff of 12 Mev—more than twice the energy of the largest now in operation. The Massachusetts Institute of Technology, under contract with the Office of Naval Research, is designing and constructing the only other Van de Graaff known in this energy range.

The Oak Ridge National Laboratory has almost completed the modification of its 2-Mev Van de Graaff. Previously employed for electrons only, it will accelerate protons and other positive particles.

A 100-Mev betatron, ordered for the Oak Ridge National Laboratory but not now required there because of changed programs, will be lent to the National Bureau of Standards.

This report also outlines the AEC program in all phases of medicine and biology, reviews research results and projects under way, reports what is known of the effects of radiation on man and other living things, and surveys the benefits which may be derived from the use of radiation to diagnose and treat disease, and to study plants and animals. Since radiation from atomic sources also is potentially harmful to all living things, the Commission has set up safeguards for all who might, without such protection, be exposed to harmful radiation. The report outlines these, and surveys the effects of atomic-bomb radiation upon people, plants, and animals at Nagasaki and Hiroshima, and at Bikini and Alamogordo.

Supersonic Wind Tunnel

FIRST disclosure of operating details on the fastest of three giant tunnel installations for studying supersonic flight was made recently by the National Advisory Committee for Aeronautics and the Allis-Chalmers Manufacturing Company. The 4 × 4-ft tunnel has been in preliminary operation at Langley Aeronautical Laboratory in Virginia for the past year.

The new tunnel has design characteristics making it specially suited for the study of certain aspects of the over-all study of flight at speeds faster than sound. NACA supersonic tunnels at the Ames Aeronautical Laboratory at Moffett Field, Calif., and at the Lewis Propulsion Laboratory at Cleveland, Ohio, are probing still other phases of the problem.

The Langley Tunnel permits the use of test models large enough for installation of extensive instrumentation. A 32-in-span model of a complete supersonic airplane now under investigation is fitted with movable controls and more than 300 pressure orifices.

Current tests are providing detailed information on viscous and interference effects, which were unobtainable in the smaller supersonic tunnels. Among other problems being investigated in the new tunnel at Langley is the phenomenon of shock-wave detachment at the leading edge of supersonic wings.

The new research unit is equipped with a specially designed axial compressor which generates a flow up to 870,000 cu ft of air per min and is believed to be the most efficient device ever built for the movement of air. It was designed and constructed by Allis-Chalmers in conjunction with NACA Langley engineers.

The seven-stage, 11-ft-diam, 1137-blade compressor operates at tunnel pressures from 0.25 to 2.5 times atmospheric pressure and requires up to 60,000 hp to drive it. It circulates air through the test section of the tunnel at velocities ranging from 1.2 to 2.2 times the speed of sound.

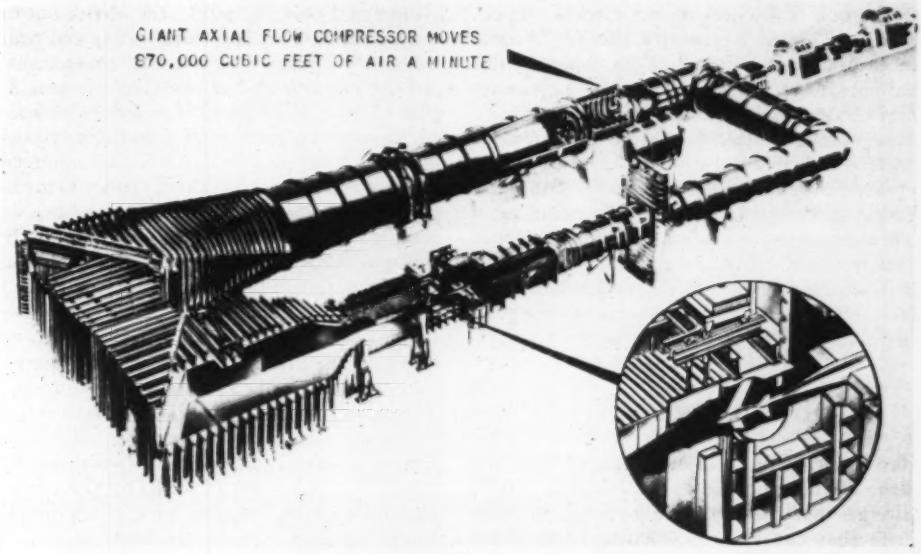

FIG. 1 4 × 4-FT SUPERSONIC WIND TUNNEL

The tremendous size of the tunnel compressor—it is 11 times larger in volume of air handled than the largest standard commercial compressor built to date—can be imagined from its total weight of 140 tons. Total weight of the blading is about ten tons, the separately forged steel blades measuring 6 in. wide and from 9 to 14 in. in length. The bladed rotor weighs about 65 tons.

Tip ends of the rotor blades are approximately 11 ft in diam and travel at a speed of around 560 mph when the unit is running at maximum speed. The $12^1/_2$-ft-diam compressor cylinder, which is an integral part of the wind tunnel, is split in halves. Each half is mounted on rails so it can be unbolted and moved back to facilitate internal inspection of the compressor.

Operating velocities in the tunnel's test section can be varied by adjusting the flexible 25-ft-long walls of a nozzle ahead of the test section. By means of gates, the test section can be isolated to permit model changes without returning the entire tunnel to atmospheric pressure.

Drying and cooling equipment in the tunnel reduces moisture content of the air to as low as one part of water in 10,000 parts of air and stagnation temperature from 250 F to about 110 F.

Press Fits

A PAPER discussing the press fit between the railway car wheel and axle was presented by H. J. Schrader, Mem. ASME, research professor of theoretical and applied mechanics, University of Illinois, Urbana, Ill., during the 1948 ASME Annual Meeting, New York, N. Y.

He pointed out that both the machine-shop and mounting practice have greatly improved during the past decade, but the number of wheels loose on axles have not been reduced to a desirable minimum. It may be that the higher speed of both freight and passenger trains has a more detrimental effect than the benefit derived from the better machine-shop and mounting practices.

In general, mathematical analyses of the press-fit problem are an extension of Lamé's solution of stresses in thick-walled cylinders subjected to internal and external pressure, to cover the special condition of the press-fit problem.

When a thick-walled cylinder is subjected to an internal pressure the body will deform in a radial direction away from the center; likewise, when a solid cylinder is subjected to an external pressure it will deform in a radial direction toward the center. The hub of a car wheel can be considered to be a hollow cylinder and the axle a solid cylinder. The internal pressure acting on the hub is equal to the external pressure acting on the axle and when assembled these pressures are equal.

With given diameters of the hub and axle and with the equations for finding the stresses in thick-walled cylinders as developed by Lamé, it is possible to determine the pressure that exists between the hub and axle. This solution assumes a uniform pressure between the hub and axle which is true if the axle does not extend beyond the hub faces, or if the shaft does not deform under the pressure. In practice both of these occur, and there will be an increase of stress at the junction of the axle and hub faces.

During a series of mounting tests, ten wheels were tested. The mounting allowance and the lubricant followed AAR standard recommendations, that is, the allowance was 0.0015 in. per in. of diam and the lubricant was 12 lb of white lead to 1 gal of boiled linseed oil. The speed of mounting was much slower than railroad practice. At each inch of progress, the loading was stopped and a set of strain measurements were taken. With the slow mounting speed the mounting pressures for several of the wheels were below the AAR minimum limits.

Two wheels were mounted on axles with ground wheel seats. These wheels showed considerably higher mounting pressures than those for comparable wheels mounted on turned seats. The bore of the wheels was not ground in either case.

Four wheels were used in repeated mounting tests, two were mounted four times, and two were mounted six times. The load required for the second mounting was from 28 to 41 per cent greater than for the initial mounting. With further mountings there was a large increase in the case of one wheel, an appreciable increase for another wheel, and little change for two wheels.

In the foregoing repeated mounting tests the wheels were mounted in about 20 sec in some cases, and in about 10 min in others. For the few tests made there seem to be no consistent effects of mounting speeds upon the loads required to press the wheel onto the axle.

Mounting tests on relatively few wrought-steel wheels indi-

cate that strains in the hub of a wheel are not always proportional to the mounting pressures. Apparently, small differences or irregularities in the surface finish and slight tapers of the wheel seat or wheel bore, have a great influence on the mounting loads and wheel strains, and some wheels requiring high mounting loads may not be subjected to strains as great as those existing in wheels mounted with lower mounting loads.

Some European practices were also discussed by Mr. Schrader. He said that the main difference is that the Europeans use a wheel center and shrink on a tire. The wheel center is forged of a material which is considerably lower in carbon (0.18 to 0.20) than is used in wheels for any American railroads. The mounting allowance, lubrication, and allowable mounting pressures are practically equivalent to U. S. practices.

Helioplane

THE goal of just about everyone in or associated with the personal airplane business for many years has been a spinproof stallproof aircraft that could operate from an extremely short one-way strip, that had built-in stability at minimum speed, and that would be quiet enough to satisfy the most exacting noise-conscious property owner.

An airplane which, it is believed, meets all the foregoing specifications and provides a few more desirable ones, has been developed by Otto C. Koppen, professor of aeronautical engineering, Massachusetts Institute of Technology, and Dr. Lynn Bollinger, Harvard Graduate School of Business Administration, and is described in the August, 1949, issue of *The Pegasus*. They call it the Helioplane, since it is supposed to incorporate the best features of rotary and fixed-wing aircraft, and list its performace as follows:

Spinproof and absolutely stallproof. At 30 mph the Helioplane's wing is 14 deg below the stall angle.

Take-off and land with full load in still air in less than 100 ft, and clear a 50-ft obstacle in less than 300 ft. In a 10-mile wind, take-off would be possible in less than 50 ft.

Approach at about 30 mph with flaps down, and with flaps partly retracted, increase air speed to maintain 20 to 30 mph ground speed.

Cruise with full load at 108 mph at 75 per cent of rated power, using an 85-hp Continental engine, and still retain the minimum-speed performance.

As noiseless in flight as the average automobile on the highway.

In their approach to the Helioplane, Koppen and Bollinger eliminated the best boundary-layer control arrangement as too complex, sidetracked the roadable-plane idea as too premature, and the helicopter as too costly for mass sales.

They finally agreed on a combination of three things well known in the aircraft industry—leading edge slats, slotted, full-span flaps, and a high-thrust low-speed propeller—and applied them to a conventional small plane.

The slats operate automatically, retracting when the plane has attained cruising speed, and extending when it slows for a landing. The propeller is unusual for such a small craft, having a diameter of nine feet and constant-speed hub. It turns at about 1200 rpm, an important factor in keeping the plane quiet. Flaps are operated by a crank and screw mechanism in the cockpit and cannot be dumped suddenly.

This combination of propeller, slats, and flaps, plus a conventional high-lift airfoil, actually made possible a minimum speed of 27 mph for the Helioplane and, most important, that is a speed usable in flight with complete safety. Experienced pilots know that few light planes can take off or land with flying speed under 60 mph; the novice normally uses a higher speed than that for additional safety and control.

The Helioplane's slow-speed characteristic would be especially effective in bad weather. It would be possible for a pilot caught in the overcast to reduce his speed to 30 mph and, with simple instruments, descend slowly with little risk of injury to himself or airplane. If his engine failed, he could set his flaps and coast down slowly to a safe landing. Another important factor is that the Helioplane has an extremely small turning radius. An inexperienced pilot can fly low and slow in this new small plane and do it with confidence.

Construction of the first plane began late in 1948 at the Boston shops of E. W. Wiggins Airways. They intended to modify a Piper Vagabond but before they were through nearly everything on the plane was changed. It emerged as a plane that was new from the cabin back and from the firewall forward. They added 45 in. to the plane's length and the span of 29 ft is seven inches less than a Piper Cub. The plane has two doors, one on each side, and Goodyear swivel gear for cross-wind landings. The power plant, an 85-hp Continental, has fuel injection. Fuel tank installed back of the side-by-side seats has a 20-gal capacity. Other specifications are: Wing area, about 150 sq ft; maximum gross load, 1350 lb; empty weight, 850 lb; useful load, about 500 lb; wing loading, about 9 lb per sq ft.

The plane incorporates two items not standard equipment on small planes—automatic pitch control and injection carburetion.

Another innovation on the Helioplane is a yaw-control arrangement. It is accomplished by a synchronized rudder-aileron linkage and a split rudder. It enables a new pilot to achieve the co-ordination and trim only an experienced flier can achieve in the conventional plane.

Railroad Data

CLASS I railroads installed more new locomotives and freight cars in the first seven months of 1949 than in any corresponding period in approximately 25 years, the Association of American Railroads reports.

Class I railroads put 1157 new locomotives in service in the first seven months of 1949, the largest number for any corresponding period since 1923. These included 1112 Diesel and 45 steam. New locomotives installed in the same period of 1948 totaled 762, which included 730 Diesel, 28 steam, and 4 electric. They also had 1009 new locomotives on order on Aug. 1 of this year, which included 25 steam, 4 electric, and 980 Diesel.

Class I railroads and railroad-owned private-controlled refrigerator-car companies put 60,486 new freight cars in service in the first seven months of 1949. This was the greatest number installed in any corresponding period since 1926. In the same period of 1948 there were 58,892 put in service. Of the total number installed in the first seven months of this year, there were 10,649 box, which included 10,549 plain and ventilated, and 100 automobile boxcars; 4203 refrigerator; 11,667 gondola; 32,258 hopper, including 2856 covered hoppers; 500 stock; 191 flat; and 1018 miscellaneous freight cars.

Class I railroads and railroad-owned private-controlled refrigerator-car companies installed 5328 new freight cars in July. In June the figure was 7060.

All railroads and private-car lines had 36,564 new freight cars on order on August 1, 1949. Of this total, Class I railroads and railroad-owned private-controlled refrigerator-car companies had 33,658 new freight cars on order. They were as follows: 6374 box, including 6074 plain and ventilated, and 300 automobile boxcars; 12,337 hopper, including 2039 covered

hoppers; 8702 gondola; 3825 flat; 2162 refrigerator; and 258 miscellaneous freight cars.

Of the total number of new freight cars which Class I railroads on Aug. 1 had on order, 16,544 will be built in railroad shops and 17,114 in outside shops.

Class I railroads and railroad-owned private-controlled refrigerator-car companies in the first seven months of this year retired 45,381 freight cars compared with 44,717 in the corresponding period last year. They retired 6721 cars in July of this year.

Heat Transfer

A LIQUID-METALS heat-transfer project, with implications in the generation of power from nuclear fission, is under way at the University of Delaware, Newark, Del., in cooperation with the Office of Naval Research. Edward C. Lawson, Jr., Jun. ASME, assistant professor of mechanical engineering, is directing the project.

Under contract to the Office of Naval Research, the university will continue its research to determine film or surface coefficients of heat transfer between steel tubes and liquid metals. The work under the present contract is to continue until next May 31. The project previously was supported by the General Electric Company.

James I. Clower, Mem. ASME, professor of mechanical engineering, who is general consultant on the project, explained that while the direct generation of mechanical power or of electricity from a nuclear reactor is not feasible at present, the use of a reactor as a primary heat source from which steam or mercury vapor can be generated is feasible. Several experimental atomic-power plants now are under construction. The only major difference between these plants and corresponding modern steam plants will be the use of slight quantities of fissionable material in a small-volume nuclear reactor, instead of the combustion of large quantities of fuel in a large-volume furnace to provide the necessary heat energy at high temperatures. A well-designed reactor will require an estimated one twentieth of the volume of a modern steam boiler, and will consume less than one ten thousandth of the volume of fuel.

The hazard of radioactive material is a considerable factor, Professor Clower pointed out, as is the lack of knowledge of the behavior of engineering materials under the simultaneous influence of high temperature, fluctuating stress, and radioactivity. This, he said, means that some shielding must be effective before the steam itself is generated, and it is a part of this problem which the Delaware research is seeking to solve.

A new type of heating element, capable of producing temperatures up to 1200 F, is being built. Mr. Lawson said the problem essentially is one of precise high-temperature measurement under difficult conditions.

Coal-Handling Systems

THE important design features, equipment, and requirements of coal-handling systems for central power plants were described by F. William Kaercher, Mem. ASME, Link Belt Company, Philadelphia, Pa., during the 1949 ASME Fall Meeting, held at Erie, Pa.

In a brief historical review, Mr. Kaercher recalled that in the early days installations generally consisted of steam cranes and so-called flight conveyers and bucket elevators. With the increase in size and height of boilers and resultant necessity for delivery of coal to high bunkers, the use of skip hoists became quite common practice for a number of years, along with the use of cable cars for distribution to bunkers.

Dragline systems were pretty much standard practice for handling coal into and out of storage piles.

For quite a long period of time, the overlapping pivoted bucket carrier was the most universally used and applicable type of equipment for serving the medium-sized plant, because of its adaptability for handling both coal and ashes, separately, of course. This machine seemed to lose some of its popularity when steam-jet and vacuum systems were adopted for ash handling.

The development of the pivoted bucket carrier dates back over more than fifty years, and it still enjoys a wide usage. It is a highly dependable unit, and its ability to both elevate and convey gives the machine more flexibility in application than other designs. The operating cost per ton of material handled is as low as that of any other type of elevator and conveyer equipment, between the capacity limits of 50 and 300 tons per hr.

Along about 1915 the use and application of belt conveyers began to increase, and since that time improvements in the construction of conveyer belts and carrying idler rolls have made this the most economical means of transporting bulk materials where conditions and space permit its use.

In the past five or six years some definitely new trends have developed which are unique to previously accepted practice. This refers principally to the handling of large tonnages of coal into and out of storage areas. Demands have greatly increased for larger reserve-storage supplies of coal, and it has evolved that the application of bulldozers and carry-alls offers an economical and flexible method for storing out coal over large areas, and to varying depths. The uniform spreading and packing action resulting from this method has greatly reduced fire hazards.

Mr. Kaercher cautioned that an important point to keep in mind in applying this handling method is the necessity for extremely strong and heavy hopper gratings, in order that these will carry the load and impact of the heavy machines.

Some of the standard units described by Mr. Kaercher were the following:

Track Hoppers. Railroad cars are spotted over track hoppers, car doors are opened, and the free-running coal pours into the track hopper and is then handled over the conveying system.

Rotary Dump. The gondola car dumper overturns and discharges the contents of the smallest or largest open-top car of any type, within two minutes if desired.

Car Shaker. Where the capacity of coal handled is at rates which will not justify the installation of a gondola car dumper, the car shaker has been found to fill this need.

Feeders. Under track or rotary dump hoppers, feeders should be used to control the capacity requirements of the particular installation.

Crushers. Bradford breakers and crushers are usually installed in conveying systems where large capacities are handled, not only for primary crushing of run-of-mine coal, say, to $1\frac{1}{2}$ in. and under, but also for the removal of foreign materials such as large pieces of lumber, car couplings, straw, bags, and the like.

Overlapping Pivoted Bucket Carrier. This is probably the most applicable type of conveying equipment for serving the medium-sized plant, as it performs several functions of receiving both the coal and ashes, separately; in its lower run conveying the material to one end of the boilerhouse, elevating it, and then conveying it to the overhead coal or ash bunker, where the contents of the buckets are dumped and distributed.

Skip Hoist. Should the supply track be located alongside or at the end of the boilerhouse, the skip hoist is well suited

to elevate the coal and dump it into the overhead bin direct, or onto a belt or flight conveyer for distribution to a long overhead bunker.

Belt Conveyers. Belt conveyers are extensively used where large capacities are to be handled and high lifts are encountered.

Belt-Conveyer Enclosed Bridge. A belt conveyer running in an enclosed bridge has a number of advantages since at all times the operator can watch the action of the belt and the idlers, the men are protected from the weather, and also have a feeling of safety when walking or working along the elevated conveyer lines.

Belt-Conveyer Open-Type Bridges. The conveyer bridge for the open-type construction is more economical from an initial-cost standpoint, perhaps does not gather as much dirt along the walkways due to the wind blowing it off, and if the covering over the conveyer belt itself is properly designed the belt and idlers are readily accessible.

Chutes. The design of chutes has changed in the last couple of years. Because of poor-quality low-grade fuel containing fine clay, sand, and dirt, it has been necessary to design chutes on a much steeper angle than heretofore. While a few years ago, the accepted maximum angle for chutes handling fine coal was 45 deg, today it is necessary to go as steep as 70 deg or more, in order to have the coal flow properly.

Traveling Weight Larry. Ordinarily, the overhead storage is located in front of the boilers, but there are conditions where it is desirable to place it centrally with or at one end of the boiler house and distribute the coal to the stokers as needed, by means of a traveling weight larry.

Side-Car Carrier. A new type of conveyer adaptable for handling coal from overhead bins to stoker hoppers is known as the side-car carrier. This conveyer is of the run-around type, travels in a horizontal plane, is self-discharging, and requires little head room.

British Aircraft Display

THE tenth Flying Display and Exhibition of the Society of British Aircraft Constructors was held from Sept. 7 to 1[illegible] 1949, at Farnborough Airfield, England.

Of the 59 airplanes taking part, 24 were powered by turboprop or turbojet engines. Fourteen airplanes (12 of them gas-turbine-engined) were shown for the first time.

The aircraft arousing greatest interest at the exhibit were the first British jet-bomber (the Canberra I); the Comet four-jet airliner (see MECHANICAL ENGINEERING, October, 1949, page 840); the Tudor 8 four-jet experimental airliner; and four turboprop-engined airliners, Apollo, Hermes V, Mamba-Marathon, and Viscount. Only the Viscount had appeared before, at the SBAC 1948 show. Interest was widespread also in the Bristol Brabazon I, which flew over Farnborough Airfield on Sept. 8. In a five-minute demonstration, the Brabazon made two low-level runs across the airfield. Since her first flight on Sept. 4, the Brabazon had completed some 4 hr in the air.

The four-jet de Havilland Comet airliner gave six-minute daily demonstrations at the SBAC show.

In the 26 days following her first flight on July 27, the Comet completed more than 35 hr of flying. The four Ghost turbojets were removed for routine inspection after 26 hr. Powerplant replacement takes only one hour.

By the time the airplane completed 20 hr flying time, it had attained 37,500 ft and a true air speed of 450 mph. Speed and altitude are slowly being increased during the exhaustive development trials, which will continue for some months.

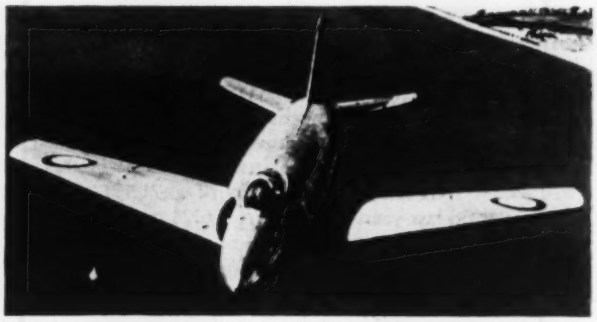

FIG. 2 NEW SUPERMARINE 510 SUPERSONIC JET FIGHTER

(Shown at the British Aircraft Constructors Display, Farnborough, England, the new Vickers Supermarine 510 jet fighter is claimed to be capable of reaching a speed faster than sound. The Royal Air Force is to be equipped with this aircraft which is still on the secret list.)

Released from the secret list in time for the show were three new British jet fighters—the de Havilland 113 and 112 Venom, and the Avro 707. The Venom has been developed from the de Havilland Vampire. A single-seater, high-altitude interceptor, the Venom is powered by a Ghost turbojet of 5000 lb static thrust. The de Havilland 113 is a night fighter with a twin-boom fuselage. Both the 112 and 113 took part in the SBAC flying display.

The Avro 707, which is powered by a Rolls-Royce Derwent turbojet, flew for the first time on Sept. 4. It has triangular delta wings, swept back to delay compressibility. Speed and performance details are secret.

Other new fighters shown were the Hawker P 1052, the Vickers Supermarine type 510, the Meteor 8, and the Python-Wyvern.

Sixteen different engines were shown on individual stands at Farnborough, while seven more types were installed in aircraft. Greatest interest of course was centered around the turbojet and turboprop engines.

The only new engine exhibited at the SBAC Exhibition, however, was the Double-Mamba. This is a combination of two separate and distinct Mamba engines, each with its own fuel, lubrication, and control systems and its own reduction gear (see MECHANICAL ENGINEERING, July, 1949, page 594).

Gasoline From Coal

UNLIMITED quantities of premium motor gasoline now could be produced from coal at a cost that would increase the current service-station price to the consumer by only 3 to 4 cents per gal, James Boyd, director of the Bureau of Mines, said recently in a new report on estimated plant and operating costs for coal hydrogenation. Through the sale of by-product phenols, for which demand may be limited, a few initial plants could produce gasoline at even lower cost.

Said to be one of the most comprehensive and significant studies completed thus far under the synthetic-liquid-fuels research and development program, this report clarifies many of the inconsistencies found in published cost estimates for producing such fuels commercially.

In recognition of the complex factors responsible for these wide variations in estimates, two sets of cost calculations are presented—one for a modernized plant incorporating process improvements, and the other for a conventional plant following European practice. In addition, basic calculations are given for five typical coals: Pittsburgh-seam bituminous, Wyoming

and Illinois bituminous, Montana subbituminous, and North Dakota lignite.

The study indicates that the capital investment for a modernized commercial plant with a daily capacity of 30,000 bbl would range from 243 to 258 million dollars, depending on the coal used. Improvements incorporated, such as the gasification of coal under pressure, reduce the investment and operating costs and increase the thermal efficiency materially in comparison to plants built in England and Germany prior to 1939.

Included in the report are detailed cost estimates for individual sections of the plant, together with plant and process descriptions, flow diagrams, plot plans, materials balance sheets, and 55 tables listing and comparing numerous factors influencing costs.

A free copy of Report of Investigations 4564, "Estimated Plant and Operating Costs for Producing Gasoline by Coal Hydrogenation," may be obtained by writing to the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa.

Geiger Steel Analyzer

THE Geiger counter has been adapted by scientists of the Research Laboratory, United States Steel Corporation of Delaware, to the development of a quick and accurate method of analyzing steel samples. After some of the problems that remain are solved, Geiger-counter analysis is expected to be even faster than the direct-reading spectrograph.

Just as it is capable of detecting and measuring radioactivity, this instrument is capable also of measuring invisible fluorescent rays, each of a special kind, that emanate from a steel sample when its atoms are ionized by powerful x ray.

The sample's iron atoms and the atoms of alloying elements are not smashed in the analysis process, as might be expected. In fact, the steel sample is in no way harmed or changed.

Geiger-counter analysis is said to be simpler to make than an ordinary chemical or a spectrographic analysis of steel. Almost any piece of steel that has a flat surface will do for the purpose, so long as it is reasonably clean. Thus analysis might be made of a random section of steel rail, the bottom of a cooking pot, a knife-blade, or a flattened mass of steel file dust.

A 20-milliamp 50-kv molybdenum target x-ray tube is used in the laboratory studies. The ray floods the steel specimen, exciting secondary rays which are characteristic of the chemical elements alloyed with iron in the sample. These fluorescent rays are reflected through a narrow slit at right angles to the path of the primary x ray to a crystal monochromator. This crystal is in the center of a circle one fourth of whose circumference is traversed by the Geiger counter in its round of analysis. The counter is moved by motor in this scanning operation. See frontispiece, page 890 of this issue.

When used by a prospector for detecting radioactive substances in nature, the counter indicates their presence by clicks which can be counted accurately. The instrument used in the Kearny laboratory has a counting circuit, like other laboratory counters. In this case, however, the counter has been connected to a standard recording instrument, a self-balancing "potentiometer," which automatically plots the intensities of the various elements on graph paper.

This method of analysis is best adapted to detect and measure elements of "middle" atomic weight. Among these are the elements most often combined with iron and carbon to form the various steels in common use—chromium, manganese, molybdenum, and nickel, as well as copper, which is frequently added to a steel composition to lessen corrosion. Also included in this class of alloying elements are some whose use is growing more and more frequent, such as columbium, titanium, tungsten, and vanadium.

Nylon

HAVING captured 90 per cent of the women's hosiery market, nylon is looking to new fields for future growth, according to the *Industrial Bulletin* of Arthur D. Little, Inc., September, 1949. Industrial applications already use a substantial portion of the nylon fiber, which is produced at a rate estimated in the trade, but unconfirmed by du Pont, at 75 million lb per year. The tire cord market, for 500 million lb of fiber, is perhaps potentially available. Expansion into men's and women's apparel offers the most immediately promising outlet.

So far, nylon is relatively unimportant as a textile—of the 12.4 billion yards of broad woven fabrics produced in 1948, cotton accounted for 78 per cent; rayon, 17.7; wool, 3.7; and silk and all synthetic fibers, only 0.6 per cent. About half of this last, or 33 million yards, is nylon fabric.

Knit nylon for lingerie and dress fabrics, relatively new to the textile field, now rivals the nylon-hosiery market in size, with estimates of 20 million lb to be produced in 1949. Nylon tricot, an interlocked flat knit fabric is particularly popular for underwear because it fits well, with little tendency to sag after continuous use. Low moisture absorption and smooth fiber surface produce fabrics not readily soiled, which may be washed and dried quickly without ironing. Absorbency, however, may give cotton or wool an advantage for some underwear and socks. Businessmen are attracted by nylon shirts which may be easily washed in a hotel room and worn without ironing.

For lightweight garments subjected to hard wear, such as sports uniforms or raincoats, the high strength and elasticity of nylon are advantageous. A high softening point enables nylon fibers, preset for a desired shape, to be subjected to normal use without stretching or shrinking.

Increasing production of nylon staple, or short fibers, has particular significance, since most textile fabrics are blends of various fibers processed on cotton or wool machinery. Because nylon has much greater strength than is necessary in a dress, a blend of nylon and rayon makes a less expensive dress fabric than straight nylon. The staple form of nylon is used increasingly in rugs, carpets, blankets, sweaters, and upholstery.

Despite this expansion into the general textile market, the special and industrial applications are still important. Exceptionally strong fishing tackle, conveyer belts, parachute fabrics, pump diaphragms, and the monofilaments widely used in toothbrushes and similar applications take about 15 million lb annually. Strong durable cord is also increasingly important.

Since nylon cord is about twice as strong as an equivalent weight of high-tenacity viscose cord and three and a half times as strong as cotton cord, it proved particularly useful during the war for airplane tires, where it saved both weight and rubber. At present, except for a few premium passenger-car tires, nylon is used only for transport plane and other heavy-duty tires. In bus tires, it is used as the outer ply, with rayon and nylon inner plies; its high bursting strength has effectively prevented blowouts. A recent study indicates not a single, blowout among the first 20,000 truck and bus tires sold, although some of the tires examined had been retreaded three times. Nylon may prove economical for such applications, since bus companies customarily purchase tires on a service

basis, contracting for supplies over a definite period, rather than by a fixed price for individual tires.

Since it requires five to ten years to establish a new fiber in tires, it is not possible to project accurately the future of this use of nylon. Further improvements in rayon and possibly other synthetic fibers may offer competition in this and other fields.

In any estimate of possible markets, price is the limiting factor. Ability of rayon to approach the price of cotton has been the most important factor in tripling rayon production in the last ten years. In addition to heavy research expenditures and the large plant investment required, manufacturing costs for synthetic fibers are high; future price reductions depend on cheap raw materials and improved methods for volume production. Even limited to specialty end uses, where specific properties command a premium, nylon can be expected to make significant inroads on the fiber market, which consumed 6.3 billion lb of cotton, wool, and rayon in 1948. Already nylon is big business; the estimated 75-million-lb annual production is worth $150 million as yarn and staple fiber.

Ore Beneficiation

FIRST-GRADE iron-ore deposits in the United States are fast running out, according to the *Westinghouse Engineer*, September, 1940. At the current rate of production, the article states, it will last perhaps a decade, certainly no more than two, even by optimistic estimates.

However, the exhaustion of these rich deposits, which contain about 60 per cent iron, will not terminate the steel age. More vast, although poorer, deposits (25 to 40 per cent iron) provide a supply sufficient for possibly a thousand years at the present rate of annual consumption.

Conversion of lower-grade ore into satisfactory material for the making of steel requires concentration of the ore to increase the iron content before it is shipped to the blast furnace. This concentration decreases the cost of transportation and reduces the quantity of coke and limestone required in the blast furnace.

The greatly increasing demand for steel and the growing use of lower-grade ore have called for new concentrating equipments. Two have recently been developed. The first, an improved magnetic separator, is in operation. The second, a new-type demagnetizer, will be placed in service shortly.

A large portion of the iron ore available in the United States is hematite (Fe_2O_3), which is nonmagnetic—an unfortunate whim of nature, because concentration is more easily accomplished magnetically. To concentrate hematite-bearing ore magnetically, it must first be roasted to convert the hematite to magnetite (Fe_3O_4), which, as its name indicates, is magnetic. The magnetic-bearing ore, mixed with water, is sent to the new magnetic separator, which consists of a rotating drum enclosing stationary magnet coils in the lower portion. The drum rotates in the ore-water slurry and simultaneously magnetizes and separates the magnetite from nonferrous matter. This new design of separator produces a more effective magnetic field than previous types and hence recovers a great percentage of the magnetite. The separator was developed jointly by Jeffrey Manufacturing Company and Westinghouse Electric Corporation.

After magnetic separation, the magnetite must be demagnetized before it is fed to the classifier, which separates the finely ground material from the coarse. If the magnetite is not first demagnetized, the fine material will flocculate and will not be classified properly. The usual form of demagnetizer consists of a series of coils, energized with alternating current, that produce a progressively weaker magnetic field. As the magnetic particles pass through the field they are demagnetized.

However, this type of demagnetizer cannot completely demagnetize artificial magnetite, which is more retentive than the natural variety. The new demagnetizer differs radically in design and in the magnetic path through which the ore passes. It demagnetizes more completely both natural and artificial hematite as well as ferrosilicon, which is used in other methods of concentration. The demagnetizer is being tested by the Erie Mining Company at its experimental plant.

After demagnetization and classification, the concentrate is further processed by sintering, briquetting, or other means of agglomeration. It is then ready for the blast furnace.

Boiler-Tube Welding

A NEW and simpler process for welding boiler tubes, which effects a large saving in time, has been developed at the Chattanooga, Tenn., plant of Combustion Engineering-Superheater, Inc. According to E. C. Chapman, chief metallurgist of the company, the new method not only provides the advantages of simplicity and timesaving but also makes possible a consistently high quality of weld.

In many large modern boilers continuous tubes of lengths in excess of 100 ft are required, and to make them it is necessary to join two or more commercial lengths of tubing. The tube joints must have as much strength as the tubes themselves, in accordance with safety and boiler-code requirements.

The principles of induction heating and pressure welding are both employed in the new process which is used to make tube joints. A high-frequency generator supplies power for the induction coil, the heating from which serves in effecting a pressure-type weld. A feature of the new apparatus is an enclosed atmosphere to protect the welding surfaces against oxidation during the heating period.

Both straight and bent tubing may be welded by this method, which is expected to be less expensive and more uniform than hand welding and avoids the complications of internal cleaning that is required when flash welding is used. By combining induction heating and pressure welding, pressure-type welds may be made without objectionable upsetting of metal in the welding zone.

Tubes, drum hanger rods, and headers may be welded by this process, which is capable of handling materials ranging from 1 in. to 10 in. in diam. Actual welding time is but a few seconds, depending upon the size of material. The use of backing rings is avoided, and welds may be made of one alloy steel to another or of alloy steel to carbon steel.

Negative Spring

AN elastic member which, contrary to accepted engineering principles, resists less the more it is deformed, has been invented by W. J. Cook, general manager of Hunter Spring Company, Lansdale, Pa.

In addition to its negative force-deflection characteristic, the springlike new device, called the neg'ator, has four other properties of significance to engineers dealing with springs, wire forms, or spring products: (1) enormous expandibility and range of action (up to 50 times any original dimension), (2) the ability to act around corners and through small openings with the same freedom as nonelastic bands or cables, (3) high initial force in resisting the very increments of deflection, and (4) the ability to store and deliver approximately twice as

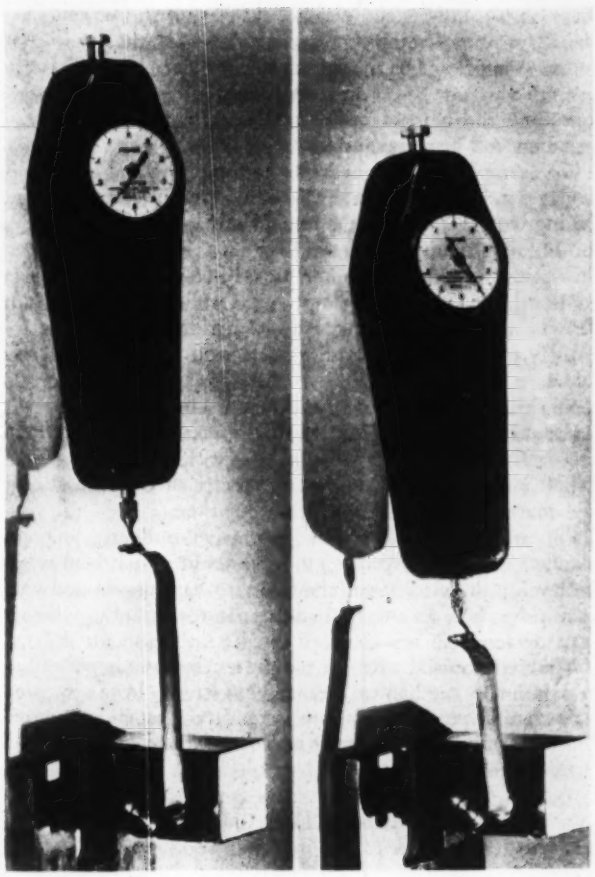

FIG. 3 UNUSUAL PROPERTIES OF THE NEG'ATOR ARE SHOWN IN THIS PHOTOGRAPH

(The force of the neg'ator decreases one third with only a 2-in. deflection.)

much energy as an ordinary spiral or power spring occupying the same space.

The following basic fields of usefulness have been suggested: (1) as a spring (extension or compression), (2) as a self-adjusting clamp, clip, or wrapping, (3) as a precision force adjustment, (4) as a transducer (converter of energy from one system to another), (5) as an automatic coiling device, (6) as a friction band, (7) as a telescopic tube form, and (8) as a means of transmitting power or motion.

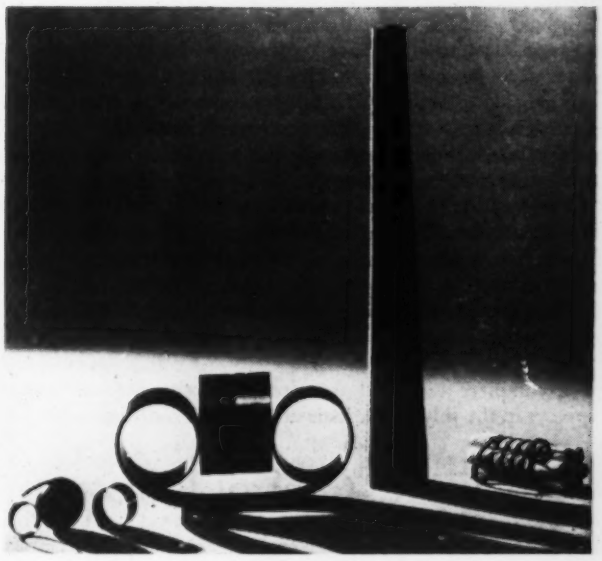

FIG. 5 SOME OF THE BASIC USES FOR THE NEG'ATOR

[*Left* to *right:* as a self-winding tape; as a clip (formed to a full 357 deg from stainless steel); as a clamp (two, 1/2-lb steel disks are being held with 16-lb pressure); as a telescopic-tube form; and as a wrapping.]

The secret of the device lies in prestressing each successive increment of length of a flat strip of spring stock by a predetermined (but not necessarily constant) amount. In its relaxed position the mechanism forms into a tight coil, each turning pressing in on the others. The familiar power spring (such as used in toys) and the simple spiral spring do not exhibit this property.

In use, the neg'ator is progressively unwound (drawn out like a tape rule) over its range of action. Its resisting force is developed as each successive length of the metal strip is drawn off the coil, and is straightened thereby. The force required to do this varies inversely as the radius to which the metal strip has been prestressed at that point. The smaller the radius the greater will be the force.

Obviously, if the neg'ator is heavily prestressed near the free end, and only lightly prestressed further along the coiled

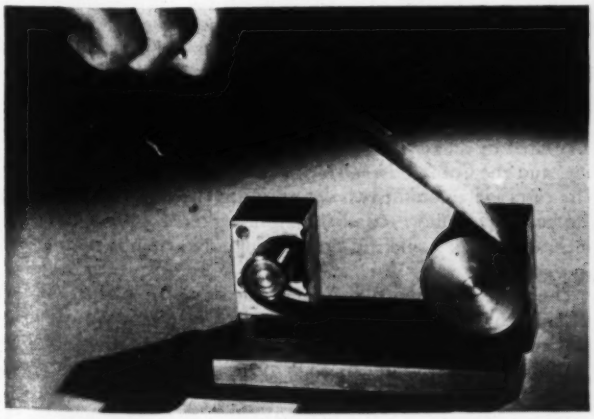

FIG. 4 THE NEG'ATOR HAS THE ABILITY TO ACT AROUND CORNERS

(A neg'ator is shown being deflected with a pull at approximately 135 deg from the normal line of action.)

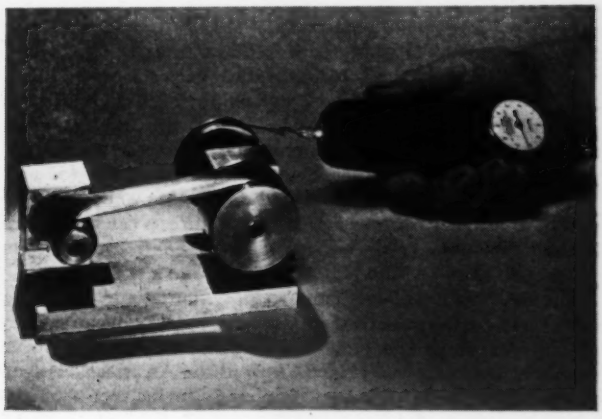

FIG. 6 IF A NEG'ATOR IS WOUND ON TWO DIFFERENT RADII SPOOLS AS SHOWN, IT WILL RUN TO THE SMALLER SPOOL UNLESS RESTRAINED

length, the device will pull back more at the beginning of its range of action than at the end of its range of action—exhibiting a negative force-deflection characteristic. If uniformly prestressed, along the strip length, the resistance of the coil to extension is uniform and constant irrespective of the extension.

Perhaps the most significant distinction from the engineering standpoint is that in any conventional spring (coil, spiral, power, torsion, or flat) the entire length of the spring stock acts like a long bent or twisted beam to produce resistance—each element of length helping to exert the total force. In the neg'ator only that short section of the stock which lies in the partially straightened zone between the tight coil and the fully straightened tail produces the resisting force at any time.

A complete technical description of the negative spring appears in the July, 1949, issue of *Product Engineering*.

Climate Control Project

A VAST program of research to define the numerous American climates in terms of how they affect housing and land development, and to create houses that are perfect (or as nearly perfect as present technical knowledge permits) in their capacity to reduce the stresses and strains of climate on the occupants and the structure, has been launched by *House Beautiful* magazine.

Speaking to more than 300 leading manufacturers, architects, scientists, and editors, at the first annual forum of *House Beautiful*'s "Climate Control Project" held at the Waldorf-Astoria Hotel, New York, N. Y., Dr. Paul Siple, consulting climatologist of the project, pointed out that for all the wide use of new techniques and materials, the house-building industry lagged sadly in the "comfort yield" of its end product. The main trouble, he said, is that we tend to build the same house all across the country. We act as though we had only one or two climates, when actually we have scores of distinctly different ones. And no one design can meet all these extremes.

Elizabeth Gordon, editor of *House Beautiful*, in explaining the project, said that what we wanted was a guide to more comfortable housing—a guide that would precisely tell homeowners, architects, and manufacturers what the climate stresses of their own region were. We wanted a check list of what things a house should do to master its climate and how it should do them.

A panel of scientists was asked to do the following: (1) Map the climates of America, (2) describe in detail what stresses they placed on man and materials, and (3) evolve performance specifications for a good house in each climate.

Using the basic data prepared by their scientists, *House Beautiful* has launched a long-range publishing program, starting with the October, 1949, issue. During the next two years, the climates of 18 of the most populous regions of the country will be analyzed; and a series of houses designed for each region will be created for editorial presentation. These houses will be as nearly perfect as we and the architects can make them in their capacity to reduce climatic stresses on both house and occupants, Miss Gordon said.

The basic technical data (tabulations, charts, and interpretations) will not be published in *House Beautiful*. But because of its significance to the home-building industry, arrangements have been made, through the *Bulletin* of the American Institute of Architects, to publish the complete scientific report of each regional analysis.

The bulk of the research has been based on Weather Bureau statistics. Weather Bureau figures deal with daily records, or with "annual means" or annual averages. But for housing purposes, working with "means" flattens out the extremes and hides, for interpretative purposes, the facts that matter to human comfort and to the performance of materials. This new research has gone back to the daily figures—even to the hourly statistics—and worked from scratch. This has produced new meanings and new conclusions.

For example, it has found, in the compiling and analysis of hourly wind data, that some climates do not have any true prevailing winds—that in some areas winds are so variable during the 24 hours in different seasons that it completely invalidates the current practice of using "prevailing winds" as a design guide. It has also been found that the wind direction in periods of extreme temperature (either hot or cold) is frequently not from the prevailing direction. This reveals how useless it is to orient a house to the prevailing winds on the theory that it would provide comfort in a heat wave.

For manufacturers of materials, contractors, architects, and engineers his research provides a new kind of information which will let them more exactly specify their jobs and engineer materials for the markets that buy them.

For architects, subdividers, operative builders, and city planners it provides specific guidance about which land is best to develop, how to orient the house to harness sun and wind conditions, how to overcome defects in topography, where to plan openings to create the wanted ventilation for different seasons, where (and when) it will be necessary to boost natural ventilation by mechanical means, what stresses from sun, wind, temperature, precipitation, and humidity must be minimized, and what climatic assets must be harnessed and prolonged.

New Mining Machines

TWO new mining machines—a scraper-shaker loader and a lightweight shearer—designed to increase efficiency in anthracite mines, are described in reports released recently by the Bureau of Mines.

The scraper-shaker loading machine was designed in the Bureau, and two shearing machines of German origin were imported from Germany and Great Britain, as part of an anthracite mechanical-mining research and engineering program begun during the war to stimulate production of anthracite and to help improve the economic condition of the industry. These publications are the first progress reports on that program.

Tests described in the reports showed that the scraper-loader could be used in driving gangways and the shearer to expedite mining in thin, steeply pitching anthracite beds. Conducted under actual mining conditions in sections of operating mines made available for the purpose, the tests also suggested design changes, the reports disclose.

The reports outline preliminary work on two of the problems suggested by an advisory committee on which management, labor, and the Commonwealth of Pennsylvania were represented. The tests were confined to determining the feasibility of using the machines under conditions encountered in Pennsylvania anthracite mines, and did not include any attempt to establish an operating cycle.

The Bureau-designed machine consists of a scraper, which gathers coal or rock from a gangway face, and an attached shaker-conveyer drive and drive trough, which delivers the material to waiting mine cars. Two unique features are pointed out—the trough can be raised or lowered to fit mine cars of various heights, and it can follow the curves often found in anthracite-mine gangways.

The reports include photographs and detailed descriptions of the machines, as well as performance charts and tables.

Free copies of Report of Investigations 4500, "Anthracite Mechanical Mining Investigations, Progress Report 1, Preliminary Underground Tests of the Bureau of Mines Scraper-Shaker Loading Machine for Driving Gangways," and Report of Investigations 4501, "Anthracite Mechanical Mining Investigations, Progress Report 2, Preliminary Testing of Eikhoff Shearing Machine, DEK," by John W. Buch, supervising engineer, and Andrew Allan, Jr., mining engineer, Bureau Anthracite Mechanical Mining Section, Schuylkill Haven, Pa., can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa. The report or reports desired should be identified by number and title.

Titanium Production

INCREASING production of the newly developed metal, titanium, was disclosed recently in a paper by E. A. Gee, J. B. Sutton, and W. J. Barth of the du Pont Company, which they presented before the Titanium Symposium sponsored by the Division of Industrial and Engineering Chemistry of the American Chemical Society, in Atlantic City, N. J.

The first small-scale commercial production of the metal was announced by the company a little over a year ago. Plant capacity was 100 lb a day. This has been increased through process improvements and additions, and plans are under way to enlarge it further next year.

The paper revealed that today the prospects for a tonnage titanium industry are especially promising. Future plans depend upon the uses developed for it by the metals industry and the volume for which there will be a market. It may be several years before these factors are known.

Until recent years, titanium metal had been considered relatively rare. The production announced a year ago was, in so far as the company knows, the first time ductile titanium metal has been produced for commercial exploration although the U. S. Bureau of Mines had produced it for research purposes.

This first year of operation has shown that it is possible to produce high-quality titanium day in and day out. Production is now consistent and quality has been improved during the year. Engineering improvements were made in the process.

It also became possible during the year to make larger ingots. First ingots weighed 10 lb and later a method was developed to turn them out at a weight of 100 lb. It was disclosed that the plant has now succeeded in making 400-lb ingots and is prepared to make them regularly.

Research on the metal is being continued by many organizations throughout the country, to determine its uses and its alloying possibilities. The paper dealt primarily with the results of research into the effect of carbon in the metal, and it was concluded that above 0.25 per cent carbon content in titanium, increasing amounts of carbon do not appreciably affect strength, but decrease its ductility slightly.

It is from this and other research work that future uses of the metal will be developed. The principal work done to date has been in fields where a high ratio of strength to weight is needed, as in aircraft, and fields where corrosion-resistant material is needed. Much testing work is being done now and it is expected that end uses will develop from this work.

Titanium metal is silver-white, light, and strong. Its corrosion resistance is said to be excellent. It is comparable to stainless steel in strength but weighs only a little more than half as much. It is less than twice as heavy as aluminum, but several times as strong.

New Navy Blimp

THE Goodyear Aircraft Corporation plant at Akron, Ohio, has started construction of a new N-type Navy blimp, specifically designed to combat schnorkel submarines. It is described in the Sept. 15, 1949, issue of the *Technical Data Digest*. When it is completed, this lighter-than-air ship will be the largest nonrigid airship ever built, although its over-all length of 324 ft is far less than the 785-ft Akron and Macon rigid airships which were flying about in the early 1930's.

The new Goodyear ship will be equipped with the latest electronic equipment for detecting and tracking undersea boats, as well as devices to refuel while in flight and rescue crash survivors. In-flight refueling will be accomplished by dropping a fuel line to surface ships, and air-sea rescues will be completed by use of an electrically operated winch which will lift injured personnel. The blimp also will be able to reballast by scooping water from the ocean.

Still another new design is the location of the blimp's 27-cylinder Wright engines within the control car. Two controllable-pitch propellers will be mounted on outriggers from each side of the car.

Nonflammable helium gas will be used in the gas bag, which has a capacity of 875,000 cu ft. Earlier M-type blimps (including the one which holds the world's sustained-flight record for airships of 170 hr) have a capacity of 725,000 ft, while the K-type ships which were used for antisubmarine patrol work during World War II contained 456,000 cu ft of gas.

Goodyear previously completed a full-scale mock-up of the 87-ft control car. This mock-up shows there will be two decks, with operating stations on the lower deck and crew quarters, bunks, and galley located on the upper. Engine repair will be possible while the airship is aloft.

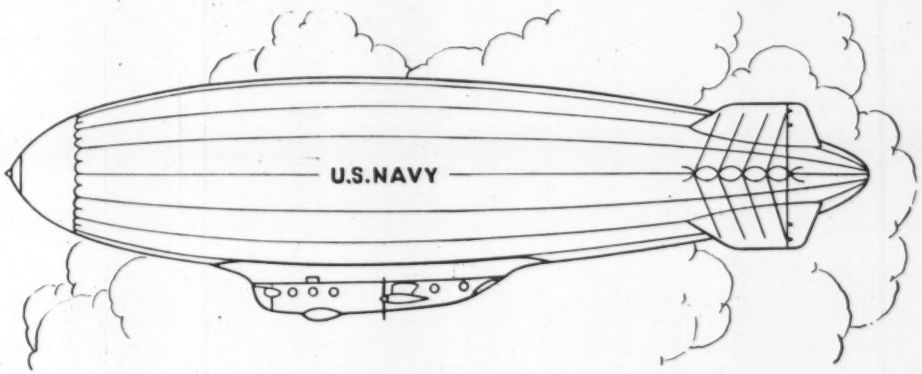

FIG. 7 OUTLINE DIAGRAM OF NEW N-TYPE NAVY BLIMP

The new blimp will have a speed of 75 knots, a maximum gross weight of 55,000 lb, and will carry a useful load of 4½ tons. Flight controls will be operated either by hand or automatically, and the airship will be equipped with a retractable tricycle landing gear.

Besides being capable of long-range patrol over ocean areas, the vessel will be able to hover over a given spot.

Motor-Vehicle Production

AMERICANS are buying and using motor vehicles at the highest rate in history, the September, 1949, issue of *Automobile Facts*, reveals.

Already it is virtually certain that 1949 will see new records in automotive production, number of vehicles in use, and total travel mileage on roads and streets.

Preliminary estimates show more than 4.2 million vehicles built in the first eight months of 1949, including 3.4 million new passenger cars—23 per cent above last year's rate.

Unless serious strikes interfere, the industry expects no trouble in beating this year the record of 5,358,420 new vehicles produced in 1929.

And by year-end there will be about 43½ million motor vehicles on our highways—35.4 million passenger cars, 7.9 million trucks, over 200,000 buses, making 2½ million more vehicles than were registered last year; nearly 8.7 million more than in 1941.

Similarly, motor travel this year is breaking all records. It will reach some 425 billion vehicle miles for the year—25 billion more than last year, 92 billion above 1941.

With this steady upward trend in postwar use of motor vehicles has come a continued rise in the many types of employment that result from production, sales, servicing, and commercial use of motor vehicles.

More than nine million persons—2½ million more than in 1941—now have found employment in these occupations, reports the new edition of "Automobile Facts and Figures," the industry's statistical yearbook.

Nearly 5.1 million persons work as truck drivers in the thousands of private truck fleets and the even greater number of individual firms that use trucks in their business activities.

More than 1½ million persons are in automotive sales and servicing jobs—in local dealerships, accessories stores, repair garages, gasoline stations.

The making of motor vehicles and parts employs 881,000 persons. Building and maintaining roads and streets employ 300,000 more. Bus operating firms have 229,000 employees.

And another million jobs are in such fields as taxi driving, car-financing companies, petroleum refining, and in the providing of raw materials and subassembly items for motor vehicles.

These nine million jobs exist in over 500,000 separate business establishments and in an even larger number of individually owned enterprises.

Steel From Sponge Iron

THE results of tests in which steel was produced from sponge iron at the Bureau of Mines pilot plant at Redding, Calif., are given in a report released by James Boyd, Bureau director.

A part of the Bureau's long-range program aimed at more effective utilization of the country's mineral resources, the tests were designed to evaluate some of the possible advantages offered by the use of sponge iron as a raw material for production of steels over the conventional scrap-and-pig-iron process.

The report describes the melting facilities used at Redding, and describes and gives the analyses of the several types of sponge iron that were used. It also discusses reducing agents, fluxes, and alloys, as well as describing the types of alloys produced and the furnace practice used.

Equations are included for calculating the amount of reducing agent that must be charged with the sponge, and also for the weight of slag formed in melting sponge iron of a given analysis and the increased power requirements for producing steel from sponge iron.

The analyses of the steels produced also are given. The report notes that the work of determining the physical and mechanical properties of the sponge-iron steels is in progress, and the results will be reported when available.

A free copy of Report of Investigation 4498, "Pilot-Plant Production of Steel From Sponge Iron," by W. W. Stephens and J. L. Morning, Bureau metallurgists, can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa.

Rugged Electron Tubes

RUGGED electron tubes are indispensable wherever electronic equipment is used under severe conditions of vibration, shock, or acceleration. Important in the development of such tubes are methods of testing for sturdiness and durability. These methods are now being studied and developed at the National Bureau of Standards as part of a comprehensive tube-ruggedization program. One phase of the project consists of a survey of the actual operating conditions for electron tubes in various kinds of commercial, industrial, and military applications. This study provides a practical basis for the design of test equipment to simulate the hazards of actual use.

In addition to working out adequate test methods, the Bureau is developing new kinds of rugged tubes. The design of these tubes is based on an analysis of the ways in which ordinary tubes fail under test or in service. A detailed knowledge of operating conditions and tube failures is thus a useful guide to the design of tubes that will be strong enough to operate properly under severe mechanical abuse. Some tubes may have to withstand great extremes of temperature as well, but in any case the mechanical design of a rugged tube is strictly governed by the required electrical properties.

The Bureau's facilities for testing the ruggedness of electron tubes now include vibration apparatus, mechanical resonance testers, high-impact shock machines, and high-speed centrifuges. Some tests are conducted with typical electrical potentials applied to the tube elements so that noise modulation, short circuits, and other effects can be studied easily. Destructive field conditions can be reproduced through the proper choice of vibration, resonance, impact, and acceleration tests.

After receiving various ruggedness tests, tubes are examined for structural failures. X rays are sometimes used to reveal the extent of structural changes without opening the tube envelope. Materials for certain tube elements are examined spectroscopically to determine their exact composition and to find impurities that might weaken the tube structure. This determination of the real causes of tube failure is an important part of the rugged-tube program. Out of these studies will come recommended specifications for materials best-suited to particular ruggedization problems. In some cases new materials and new methods of fabrication must be developed to meet the unusual requirements of ruggedization.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Gas Turbine Power

The Exhaust-Heated Gas-Turbine Cycle, by D. L. Mordell, Mem. ASME, McGill University, Montreal, Canada. 1949 ASME Fall Meeting paper No. 49—F-6 (in type; to be published in Trans. ASME).

The author describes and discusses a gas-turbine cycle in which the combustion chamber is placed behind the turbine, raising the exhaust temperature to a level at which all the heat required for the compressor air can be supplied by the heat exchanger. The possibilities of such a cycle for the utilization of low-grade solid or liquid fuels are explained and attention is drawn to the convenience with which steam can be generated from the otherwise wasted heat, and the overall thermal efficiencies which may be obtained by a combination of gas and steam turbines.

The transposition of the combustion chamber of a conventional open-cycle gas-turbine unit to a position between the turbine exhaust and the heat exchanger results in an engine arrangement which, although bulkier and less efficient than the usual arrangement, possesses advantages entitling it to very serious consideration for many applications. The main feature of this exhaust-heated cycle is the fact that the turbines operate on pure air, and the combustion products pass only through the heat exchanger, thus dispelling any serious fears of ash troubles or turbine-blade erosion. A further advantage is the ease with which steam can be generated from the otherwise wasted heat, permitting high efficiencies where the steam can be employed usefully.

Starting and control appear to present no serious difficulties, whether the unit is run on low-pressure gas, lump coal, or low-grade crude oil, any one of which conceivably could be burned in the same engine.

Circumstances where the relatively large bulk of the heat exchanger and combustor present no installational difficulty—a feature assisted by the high temperature level of combustion—make the exhaust-heated cycle, with or without exhaust-steam generation, worthy of close study.

Properties and Characteristics of Fuel Oils for Industrial Gas-Turbine Usage, by D. P. Heath and E. Albat, Socony-Vacuum Laboratories, Division of Socony-Vacuum Oil Company, Inc., Paulsboro, N. J. 1949 ASME Fall Meeting paper No. 49—F-8 (in type; to be published in Trans. ASME).

Largely as a result of the rapid wartime development of gas turbines for aircraft usage, renewed emphasis has been placed upon the development of gas turbines for industrial applications. At the present time a number of domestic organizations are quite active in this field. One of the principal industrial applications of gas turbines in the United States is their use in the Houdry catalytic-cracking process in the oil-refining industry. Recent development work is centered around their use in the field of locomotive and marine propulsion using either coal or oil as fuel. The ultimate choice of a fuel is a complex problem involving such factors as fuel cost, engine performance and maintenance, and fuel availability. In so far as fuel oils are concerned, the designer is further confronted with a wide variety of grades from which to choose. This paper presents information on the fuel

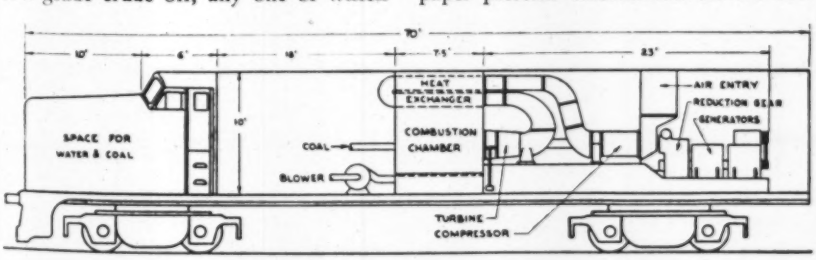

DIAGRAM SHOWING A 2000-HP EXHAUST TURBINE IN A LOCOMOTIVE

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properties and characteristics which are commonly employed for the identification and specification of such fuel oils, and also on those properties which are felt to be of significance with regard to fuel-system design and combustion-chamber and gas-turbine performance. Since fuel cost and availability are intimately related to supply and demand considerations, only limited regard is given to these factors in the present paper.

Gas Turbines for Vehicles, by Professor Frank L. Schwartz, Mem. ASME, University of Michigan, Ann Arbor, Mich. 1949 ASME Fall Meeting paper No. 49—F-12 (mimeographed).

Although most gas-turbine research and construction have been on units of 1000 hp and larger, there has been some interest in the development of smaller-size gas turbines. Recently the Department of Commerce announced the development of an automobile propelled by a gas turbine in Czechoslovakia having 60–80 hp and designed to burn naphtha, coal gas, hydrogen, acetylene, butane, or gasoline. Two automotive gas turbines have been under development in England for several years: the Centrax unit, and the Rover gas turbine. Although no announcement has been made of an automotive gas turbine in the United States, several companies have designed and built small gas turbines. The Boeing gas turbine is a 200-hp unit weighing 150 lb. It has a turbine diameter of 10 in. and a maximum combustion temperature of 1500 F. See MECHANICAL ENGINEERING, September, 1947, page 751.

The gas turbine for automobiles offers a simple device consisting of a prime mover and torque converter in a single unit. Only two rotating elements and a single speed reducer are required. Many engineers overlook the fact that the turbine is a torque multiplier. It is one of the few prime movers that is capable of producing high starting torque at low speed. The turbine exerts its maximum torque at zero speed. The gas turbine as proposed for vehicle propulsion consists of two separate turbine wheels in which gas flows in series, one to drive a compressor and one to supply power to the vehicle.

The performance of a nonregenerative gas turbine described in the paper, is as follows:

On a level road the turbine would propel the vehicle at 83 mph with a gas temperature of 1500 F. At 68 mph the gas temperature would be 1200 F, and at 58 mph, 1000 F. The torque multiplication, i.e., the torque at zero speed divided by the torque at maximum speed, is 2.75. Although this is less than the over-all torque multiplication of the gear transmission of an automobile in low gear, it is more than adequate to negotiate a 15 per cent grade.

The power turbine, which is connected directly to the axle through a gear reduction, will operate at speeds from zero to maximum. The compressor-turbine wheel, however, operates at nearly constant speed. Thus the compressor and its turbine wheel act as a producer of high-pressure high-temperature gas. Control is effected by reducing the speed of the compressor turbine, thereby reducing the pressure ratio, temperature, and air flow through the unit. The speed reduction of the gas produced need not be large to accomplish adequate control. A change in speed of the compressor of less than 20 per cent will permit operation of the power turbine over its full range of speed.

Small-Output Gas Turbines, by Anthony T. Balint, University of Buffalo, Buffalo, N. Y. 1949 ASME Fall Meeting paper No. 49—F-1 (mimeographed).

Based on the findings of a research study, this paper deals with the results of a preliminary investigation to determine the prerequisites of a small-output gas-turbine development. The term "small-output" is taken here to mean plants in the neighborhood of 10 hp.

The study began with a complete review of published literature and patents. Available literature, although rich and complete, yields no reliable basis for decisions about the possibilities of this low range of outputs. All diagrams and computed data on temperature, pressure ratio, cycle performance, etc., proved to be directed to the higher range of outputs. It thus seemed advisable to work out a set of computations to clear up the picture and find the prerequisites for units of less than 10 hp.

Since the gas turbine is to be a small-output, mobile, simple, inexpensive machine with relatively low thermal efficiency, the computations are based on the simplest thermal cycle with the minimum number of machine elements comprising: (1) A compressing unit in which atmospheric air of 60 F is compressed and delivered into (2) the combustion chamber, in which fuel is burned at approximately constant pressure, from which the hot gases pass into (3) nozzle or nozzles in which the expansion and the corresponding energy transformation into the high-velocity kinetic energy takes place. This expansion develops to approximately atmospheric pressure, and then the gases impinge on (4) the turbine wheel of the single-stage impulse type with axial admission.

The foregoing simple thermal cycles do not include any kind of a regeneration.

The field of application for small-output gas turbines, however, should not be regarded as general, but rather limited to special cases.

Aviation

The Characteristics of Elastomers With Respect to Vibration in Aircraft, by W. A. Keetch, Lord Manufacturing Company, Erie, Pa. 1949 ASME Fall Meeting paper No. 49—F-9 (mimeographed).

Because rubber is an organic material, the design of structural rubber parts for vibration control in aircraft involves knowledge not generally possessed by the aeronautical engineer. As a result, the consideration of rubber-mounting design is frequently neglected until too late in the over-all project. This paper presents basic characteristics, simplified design data, and limitations on the use of elastomeric materials suitable for structural parts, thus allowing the aircraft designer to make adequate provision for such parts, while turning the specific design over to a qualified rubber engineer. A tabulated comparison of the properties of elastomers and an extensive bibliography of material on rubber design and on vibration control are presented.

This discussion is limited to those applications which fall into the general category of structural-rubber or load-carrying parts, and in particular, where the primary purpose is the control and isolation of vibration in aircraft. The use of rubber as a structural element assumes that it is a material of known or predictable and useful characteristics.

Elastomers, the basic materials, with a minimum of compounding are capable of essentially elastic deformation of over 600 per cent. This value decreases as reinforcing materials are added until bone-hard rubber is produced, which is both brittle and of low elongation.

Natural rubber is by far the most versatile elastomer for structural-rubber parts. Room-temperature properties obtainable by proper compounding include minimum drift, minimum damping, tensile strength as high as 4500 psi, good aging, excellent flex life, and good adhesion to most metals. Principal deficiencies are low resistance to oil, ozone, and sunlight.

Of the synthetic rubbers, neoprene is

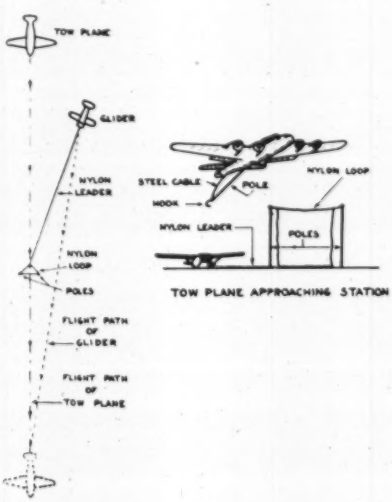
one of the most commonly used and is the nearest to natural rubber in characteristics. Its properties include excellent aging, flex life, adhesion, ozone resistance, and fair tensile strength. Oil resistance is good. Adhesion is somewhat better than with natural rubber. Modulus and hardness can be made equivalent to those obtainable with natural rubber down to a shear modulus of about 75 psi. Damping is usually appreciably higher.

Rubber offers a combination of characteristics that make it admirably suited for the control and isolation of vibration, whether that vibration be transient shock, steady state, or audible sound. When designed into equipment without serious compromise and employed within its characteristic limits, performance and service life of a rubber part are more than adequate for aircraft usage.

Aero-Hydro Glider Pickup Unit, by Alexander Cowie, Mem. ASME, Illinois Institute of Technology, Chicago, Ill. 1949 ASME Fall Meeting paper No. 49—F-10 (mimeographed).

This paper deals with the performance of a device for picking up stationary gliders by means of a tow plane in flight. The main clutching element in this device is a new development of the hydrokinetic type, and was designed and manufactured by Foote Bros. Gear and Machine Corporation, Chicago, Ill.

The glider, situated on the ground, has a nylon rope leader attached to its nose. The free end of the leader is attached to a nylon loop which is strung up between two wooden poles. The wooden pole, suspended beneath the tow-plane, supports a hook which engages the nylon loop and is disconnected from the pole at the instant contact between the hook and loop is made. The steel cable attached to the hook is guided by pulleys through the fuselage of the plane, and wrapped around a drum which is mounted in bearings in the inside of the fuselage. The drum is directly connected to the clutching element. When contact between the hook and nylon loop is made, the clutching element is practically inoperative, with the result that the drum and cable are accelerated. At a preselected time, the clutching element is applied and the drum is brought to a complete stop. When this occurs the pickup operation has been completed and the tow-plane and glider are directly connected.



RELATIVE POSITIONS OF TOW PLANE AND GLIDER DURING A PICKUP

Although this paper deals with the picking up of gliders only, the same pickup unit has been used for picking up dead weights. The first application of pickup devices was to mailbags, and during the war the military value of glider, cargo, and man pickups was demonstrated.

It is believed that the hydraulic unit, which constitutes the main energy-absorbing and clutching element in the pickup device, has certain unique characteristics which make it ideally suited for pickup work (particularly for heavy loads) and for any clutching application involving high speeds and torques.

The paper contains: (1) A theoretical analysis of a pickup operation; (2) the results of laboratory tests of the clutching unit; (3) the results of field pickup tests conducted by the U. S. Army Air Force, Wright Field; and (4) a comparison of theoretical and field pickup results.

Temperature Effects on the Axial Vibration of Turbine Disks, by J. W. Simpson, Frederick Flader, Inc., North Tonowanda, N. Y. 1949 ASME Fall Meeting paper No. 49—F-18 (mimeographed).

From time to time turbine-disk failures occur which seem incapable of explanation from either temperature and rotational stress considerations or steady-state vibratory considerations. In this paper a case is presented wherein a recurring transient condition endangered a disk previously judged safe under steady-state conditions.

The usual method of analysis is concerned with axial vibration of turbine disks under steady-state or cruise conditions. It is shown that the varying temperature distribution which exists in the turbine disk during warm-up and take-off can sufficiently lower the critical speed so that during this transient interval the disk operates at its critical for a short period of time.

Railroads

A Method for Calculating Tractive Force of Reciprocating Steam Locomotives, by John C. Wallace, Mem. ASME, Lima-Hamilton Corporation, Lima, Ohio. 1949 ASME Fall Meeting paper No. 49—F-5 (mimeographed).

The accuracy of the generally accepted methods of calculating tractive force-speed curves leaves much to be desired. In general, whereas most methods will provide a good estimate of starting power and will give reasonable correlation with actual performance at some speed, much too frequently the calculated curves fail to predict the characteristics of the performance curve over the full speed range. Failure to predict these characteristics is due to the insensitivity of the methods of calculation to the proportions of the individual locomotive which produce its performance qualities. The singularities of any given design tend to be lost in a host of averages.

A formula for approximating theoretical mean effective pressure is devised following the Kiesel pattern for simplicity.

From the indicated performance curve of a thoroughly tested locomotive actual mean effective pressure was calculated at various speeds representative of the operating range. From the steam supply corresponding to the performance curve, the theoretical mean effective pressure was calculated for these same speeds using the approximate formula.

Actual mean effective pressures were expressed as percentages of the theoretical and these percentages or diagram factors plotted against corresponding piston speed and a curve constructed to express this plot. This curve represented the combined effects on diagram factor of engine speed and cutoff.

It was assumed that there would be a corresponding curve for every locomotive, that these curves would constitute a family of curves of the same contour and having a common intercept with the ordinate, and that variation in the level and slope of these curves would be correlated with variation in cylinder dimensions and steam supply as these would govern the relationship between speed and expansion ratio and hence the sum of their respective effects.

Determination of the extent of shift of diagram factor with change in the relationship of cylinder displacement to steam capacity was made by determining the implied shift from test data of a loco-

motive differing widely from the first engine and operating at or near capacity. It was assumed that this shift could be expressed as a straight-line function of some coefficient expressive of the relationship between cylinder displacement and steam capacity. With this coefficient determined, the diagram factor first obtained could then be adjusted up or down to apply to any locomotive considered.

Thus a system results by which power at any speed can be calculated by first determining the theoretical mean effective pressure at this speed from the engine dimensions and a steam supply either calculated or assumed, and then in turn multiplying the theoretical mean effective pressure by the diagram factor corresponding to the speed considered and the cylinder displacement to steam capacity ratio of the locomotive.

Oil Firing

Oil-Fired Settings for Small Boilers, by Kalman Steiner, Mem. ASME, C. Hoffberger Company, Baltimore, Md. 1949 ASME Fall Meeting paper No. 49—F-16 (mimeographed).

Many factors enter into the design of the setting and furnace of an oil-fired boiler; in the case of industrial and power-plant boilers, the design usually takes cognizance of the engineering problems, but in the case of smaller boilers the design may overlook fundamental requirements. Various methods of rating these boilers are discussed and some suggestions offered for further standardization. A brief review of the subject of heat-release rates, followed by discussion of typical boilers, and illustrations of correct settings, is presented.

The diversity of units in use of expressing boiler capacity gives rise to confusion in formulating concepts of relative performance ability of different boilers. Furthermore, even when the significance of the units is understood, boiler capacities can be expressed on different bases, again tending to create uncertainty. The entire matter can be greatly assisted by dropping all other units and bases in favor of the single expression—gross hourly Btu output.

Boiler catalogues, smoke-abatement codes, and other documents pertaining to furnace design do not agree or attain uniformity in respect to the fundamental design factor—rate of heat release. Information and illustrations contained in boiler catalogues do not assist in clarification, and in fact, may impart erroneous concepts of boiler setting.

Boiler settings should be designed from the viewpoint of flame impingement, attaining maximum efficiency and increasing refractory life. A safe maximum rate of heat release for small boilers having refractory firebox and carrying moderate-continuous load under natural draft seems to be about 24,000 Btu per cu ft of furnace volume per hr, which is equivalent to 2 cu ft per developed boiler hp.

Practical Considerations in Industrial Oil Firing, by H. E. Schwiebert, Socony-Vacuum Oil Company, Inc., New York, N. Y. 1949 ASME Fall Meeting paper No. 49—F-17 (mimeographed).

The decision to use fuel oil rather than coal or gas should take into consideration several important factors. The first of these is economy. Another important factor is the present availability and probable future supply of the various fuels under consideration.

The last factor concerns the suitability of the various fuels for the particular application under study.

After oil firing is decided upon, attention is directed to the equipment to be used.

The selection of burner type involves matching burner characteristics to the requirements of the specific combustion problem. Frequently any one of several types will give equally good results for a particular purpose. A large number of different oil burners are available for industrial work. These fall into one of the following groups: Steam-atomizing burners, high-pressure air-atomizing burners, oil-pressure-atomizing burners, low-pressure air-atomizing burners, and rotary-cup atomizing burners.

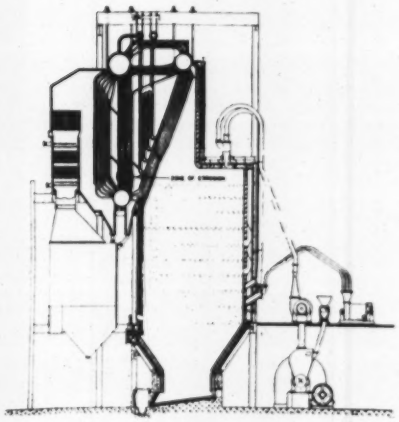
The paper discusses burner and air adjustment, combustion space, fuel-oil factors, and residual fuel-oil supply.

Fly-Ash Erosion

Fly-Ash Erosion in Boilers, by Arthur R. Weismantle and Nicholas Artsay, Foster-Wheeler Corporation, New York, N. Y. 1949 ASME Fall Meeting paper No. 49—F-21 (mimeographed).

This paper describes the experiences of one boiler manufacturing company with fly-ash erosion in various boiler units. The particular cases are described in detail. From these experiences certain qualitative conclusions are drawn, summarizing the causes of fly-ash erosion. Certain limiting values of the factors, found by this company's experiences, are given.

Fly-ash erosion in boilers is an extremely complicated process which, being dependent on many factors, cannot



EXAMPLE OF OCCURRENCE OF FLY-ASH EROSION IN A 175,000-LB PER HR PULVERIZED-ANTHRACITE-FIRED STEAM BOILER

be described in exact terms. However, it appears that erosion occurs when certain threshold values of a group of the factors are exceeded simultaneously. For instance, when considering any particular local condition in a boiler, there is a minimum velocity below which particles are nonerosive, a minimum hardness of fly-ash particle which will erode a given metal, and a minimum linear size of dust particle which will cause erosion. All of these limiting or "threshold" values of such factors must be exceeded together for fly-ash erosion to occur. There are undoubtedly many boilers operating, without trouble, in which only one or two of the threshold values are exceeded throughout the convection zones. If all three were to be exceeded, fly-ash erosion could be expected.

As more information becomes available on the subject of fly-ash erosion in boilers, it should be possible to accurately set design values for all factors. For the present it is believed that velocities up to 60 fps between and across tubes should be safe with pulverized-bituminous-coal firing. For pulverized anthracite, safe values of velocity are from 45–50 fps under similar conditions. With armored surfaces, such as the cast-iron extended type, velocities up to 80 fps for bituminous coal, and 65 fps for anthracite coal, are acceptable. When gas flow is parallel to tubes, velocities approximately 70 per cent higher than just mentioned are permissible.

In spreader-stoker-fired units which have been installed by this company, velocities across and between tubes have not exceeded 60 fps. Fly-ash erosion has not been reported on such units operating for many years, so it is believed these velocities are safe for this firing method.

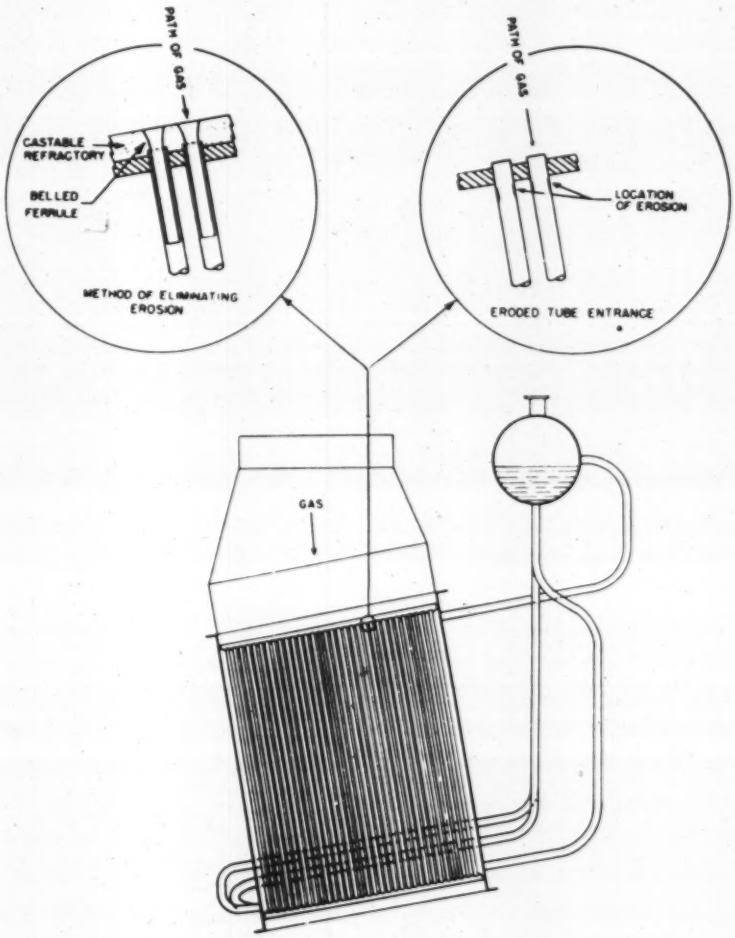
Fly-Ash Erosion of Boiler Surface, by W. D. Stevens, Mem. ASME, Babcock and Wilcox Company, New York, N. Y. 1949 ASME Fall Meeting paper No. 49—F-23 (mimeographed).

Fly-ash erosion of boiler surface is caused by fly-ash impingement at high velocity.

Over a period of many years boiler ratings have gradually increased. This has resulted in higher gas velocity through the boiler and other heat-recovery surface. During the past ten years the gradual increase in velocities has reached the point where erosion of the heating surface by particles entrained in the gases has been encountered on boilers fired by solid fuels. The erosion has not been confined to one fuel or type of firing, but it has been more prevalent on spreader-stoker-fired units because of the comparatively large quantities of heavy ash particles which are entrained in the products of combustion by this type of firing.

The tube erosion observed has been associated with one or more of the following conditions: (1) Streams of ash which have concentrated on baffles due to centrifugal force caused by turning the gas; (2) ash particles well distributed in a high-velocity gas stream which erode an entire face of a tube bank; (3) particles leaking at high velocity through baffles; (4) ash carried by high-velocity gas flowing in wide lanes between the heating surface and the walls; (5) ash caught in eddy currents around U-bolts or other projections erodes the surface close to the projection; and (6) extremely turbulent conditions at the entrance to the tubes of a fire-tube boiler before the gas straightens out for long flow through tubes.

The conditions which result in fly-ash erosion are enumerated and typical examples are described. Methods of preventing erosion by proper design and operation are presented. These methods are the results of field observations and statistical study of actual operating units.



PREVENTION OF EROSION IN FIRE-TUBE BOILER

Fly-Ash From Stokers, by E. M. Powell, Mem. ASME, Combustion Engineering-Superheater, Inc., New York, N. Y. 1949 ASME Fall Meeting paper No. 49—F-24 (mimeographed).

This paper concentrates on one of the most important fundamental causes of erosion, which is the quantity of dust passing through the boiler and auxiliary equipment, and factors which affect that quantity.

The most serious offender has been the spreader stoker.

Recently tests were completed on two units fired with continuous-discharge spreader stokers. One stoker was fired with Eastern bituminous coal equipped with a reinjection system for returning the cinders collected in the boiler, economizer, and dust-collector hoppers through the rear wall of the furnace. It was so arranged that during the tests the cinders from the dust collectors could be weighed separately and reinjected into the furnace or thrown away. Provision was made for overfire turbulence by means of 30-in. air jets located immediately above the cinder return nozzles. Two jets were also located in the front wall of the furnace. Tests were run at several ratings, both with and without cinder return from the dust collectors. Dust samples were taken in the gas duct between the economizer and dust collectors to determine the quantity, fineness, and carbon content. Other data necessary for determining the complete heat balance were collected.

The other unit, fired with a Midwestern bituminous coal, was arranged to reinject the ash from the boiler hopper only, with no provision for returning the dust-collector cinders to the furnace. Complete heat-balance data were collected on this unit in addition to dust samples at the induced-draft-fan discharge and the weight of cinders collected in the dust collector. The overfire-air system is similar to the other unit, as well as the location of the reinjection nozzles.

The close agreement between these two units when not returning dust-collector cinders was surprisingly good. The firing rate has a definite effect on cinder carry-over. Without reinjection that rate varied as the cube of rating. When returning cinders from the dust collector, the rate of carry-over varied as the 3.5 power of rating. Reliable data could not be obtained with reinjection beyond a firing rate of 400,000 Btu per hr per sq ft because of the extremely large quantities of dust to be handled.

The primary function of reinjection is of course the recovery of unburned carbon in the fly ash. Tests on both of these units indicate that if the combus-

tion rate is limited to approximately 500,000 Btu per hr per sq ft, the total carbon loss in the cinders will be less than 2 per cent without reinjection. With reinjection approximately two thirds can be recovered.

Fly-Ash Erosion in Boilers, by L. V. Andrews, Mem. ASME, and C. F. Hawley, Mem. ASME, Riley Stoker Corporation, Worcester, Mass. 1949 ASME Fall Meeting paper No. 49—F-22 (mimeographed).

This article points out some of the fly-ash erosion difficulties encountered on units burning particularly abrasive material. One burns No. 4 buckwheat anthracite; the second pulverized coal and blast-furnace gas; and the last, coke breeze. These fuels cause more severe conditions than encountered in units burning ordinary coal.

The causes of fly-ash erosion have been identified with one or more of the following cases:

1 Separation and concentration of abrasive material on baffles in such manner that particles impinge on tubes as they stream off the baffle.

2 Concentration of abrasive particles by centrifugal action when dust-laden gases are forced to turn in restricted passages before passing over subsequent heating surface.

3 Localized areas where gas velocities are greatly increased by restricted gas passages.

Some design features directed toward prevention of erosion in so far as possible are as follows: The maintenance of low gas velocity in the upper furnace, particularly in the areas where the gas enters the boiler tubes, low gas velocity where turns are made, and the use of overfire air to reduce the carry-over.

Instrument Engineering

Instrument Engineering—Its Growth and Promise in Process Control Problems, by Gordon S. Brown and Donald P. Campbell, Massachusetts Institute of Technology, Cambridge, Mass. 1949 ASME Fall Meeting paper No. 49—F-11 (mimeographed).

It has been noted (1) that the last decade witnessed extensive engineering and scientific activity in the field of positional servomechanisms, (2) that the percentage of highly trained mathematicians and scientists on the staff of these activities was unusually high, (3) that many of these staff members took up work in the field without prior conditioning on the problems and with only knowledge of basic science to guide them, and (4) that technical people who intermingle at the fringe of the professions of servomechanisms and process control discuss many problems that seem common to both fields.

Servomechanisms are closed-loop or feedback control systems in which the behavior of the output is a function of the difference, or error, between the output condition existing and the output condition desired. In other words, servomechanisms are error-sensitive control systems. Servomechanisms are used for such tasks as the remote control of heavy masses as in gun drives or turrets, for industrial positioning problems, aircraft flight control, stabilization of platforms, and the like.

Because process control, servomechanisms, regulators, or governors are all feedback control systems, their basic principles are alike. However, several barriers to the interchange of ideas basic to these fields are used by the authors.

In this paper they discuss the objectives of improved control; the growth of control practices; the dynamics problem; the necessary data; measurements without shutdown; and future problems.

Heat Transfer

Temperature Charts for Heating With Internal Heat Sources, by Dr. V. Paschkis, Mem. ASME, and Prof. M. P. Heisler, Columbia University, New York, N. Y. 1949 ASME Fall Meeting paper No. 49—F-26 (mimeographed).

For the problem of heating a semi-infinite slab by internal heat sources, charts in dimensionless units are presented. Two cases are covered. One in which the body with heat sources faces an ambient of constant temperature and one where the two faces are covered by a thermal insulation.

The main restrictions are that only slabs with constant productivity of the heat source are considered, and that all properties—including the boundary conductance between slab and ambient and between insulation and ambient, respectively, do not change with temperature.

Examples are given to illustrate the application of the charts.

The charts permit the determination of the time-temperature-space relationships for any case within the following limits:

For the uninsulated slab—to a Fourier number $N_{Fo} = 650$, relative boundary resistance $m = 10$. An additional chart permits reading of the temperatures for the slab at values N_{Fo}/m up to 7.

For the insulated slab—to a Fourier number $N_{Fo} = 12$, ratio of thermal capacitances slab/insulation 4, ratio of thermal resistances slab/insulation 0.5, relative boundary resistance from insulation 0.15.

Finally, charts show for either of the two cases the minimum rate of heat input required to obtain a certain temperature.

Economic Thickness of Cylindrical Insulation, by Dr. V. Paschkis, Mem. ASME, Columbia University, New York, N. Y. 1949 ASME Fall Meeting paper No. 49—F-27 (mimeographed).

In a previous paper the heat losses from intermittently operated furnace walls were shown. Now similar graphs are given for the case of cylindrical insulation, such as in pipe coverings. For cylindrical insulation an additional variable—the inside diameter—must be taken into consideration. The curves presented permit determination of the fractional heat flow (FHF), which is the ratio of rate of heat flow in intermittent operation to that in steady state, for any single-layer cylindrical insulation within the following limits:

Ratio outside/inside diameter	$1 \rightarrow 10$
Fourier number (the length of the period "on-off" time is the "time" in	
Intermittency	$0 \rightarrow 1$
Relative outside boundary resistance	$0 \rightarrow 0.4$
N_{Fo})	$0 \rightarrow 25$[1]

[1] Can be extrapolated to $N_{Fo} = 100$.

The paper shows, moreover, how these curves can be used for the determination of the economic thickness of insulation.

Combination of Heat Sources and Sinks by the Method of Superposition, by Frank H. Bridgers, Purdue University, Lafayette, Ind. 1949 ASME Fall Meeting paper No. 49—F-13 (mimeographed).

A superposition method is proposed whereby the temperature pattern around a single buried heat source at a given temperature is used to arrive at the pattern obtained when several heat sources at the same temperature are placed at any distance apart. An equation is derived to give the "strength ratio" which is defined as the ratio of heat dissipated by one of a series of buried heat sources of equal temperature to the heat dissipated by a single heat source at the same temperature. This equation is

plotted for a specific case to show the strength ratio as a function of heat-source spacing. Experimental temperature-distribution patterns around a heated tube buried in a box of sand are shown for two specific tube arrangements: (1) The tube being the only heat source in the solid, and (2) the tube placed between two other sources at the same temperature. Although the proposed superposition method is subject to an inherent error, which may be severe at very close spacing of heat sources, the agreement between experimental and calculated results for the cases investigated in this work is good.

Production Engineering

Handling Time vs. Machining Time, by E. L. Murray, The Warner & Swasey Company, Cleveland, Ohio. 1949 ASME Fall Meeting paper No. 49—F-25 (mimeographed).

Today's search for further economies of manufacture has been particularly intense in the metalworking field. Production engineers have observed the race between improvements in cutting-tool materials and machine-tool designs for the past forty years. Consequently, speed, power, and accuracy have been spotlighted to the virtual exclusion of another important element in the production cycle—that of machine-handling time and its relation to cutting time.

Whereas cutting time is normally fixed by workpiece and machine-tool characteristics and therefore may be easily controlled, handling time is an elusive variable whose value depends on reconciling human desire and ability to the maneuverability of machine components.

Furthermore, when a machine tool is expected to handle a great variety of work in small to medium-size lots, its efficiency becomes a potent factor in production processes. This warrants the production engineer's close attention to every phase of its operation which may be changed to improve that efficiency.

This paper describes the application of the "Electro-Cycle" system of spindle control to small-size turret lathes for purposes of reducing machine-handling time in a total job cycle. A wide variety of work types in ferrous and nonferrous materials is offered with case story data substantiating percentage savings accruing to different elements in the Electro-Cycle design.

Pressure Vessels

Experimental Technique in Pressure-Vessel Testing, by L. F. Kooistra and R. U. Blaser, The Babcock & Wilcox Company, Alliance, Ohio. 1949 ASME Fall Meeting paper No. 49—F-20 (mimeographed).

Experimental development of pressure vessels has been carried on for many years during which various testing techniques and procedures were used. This paper discusses the phase of development that has taken place in the last ten years. It had long been felt that the use of a design factor of five was unnecessarily large and that it more appropriately could be called a factor for ignorance than a factor of safety. A considerable amount of work described in this paper was undertaken to reduce the number of unknown factors in pressure-vessel design.

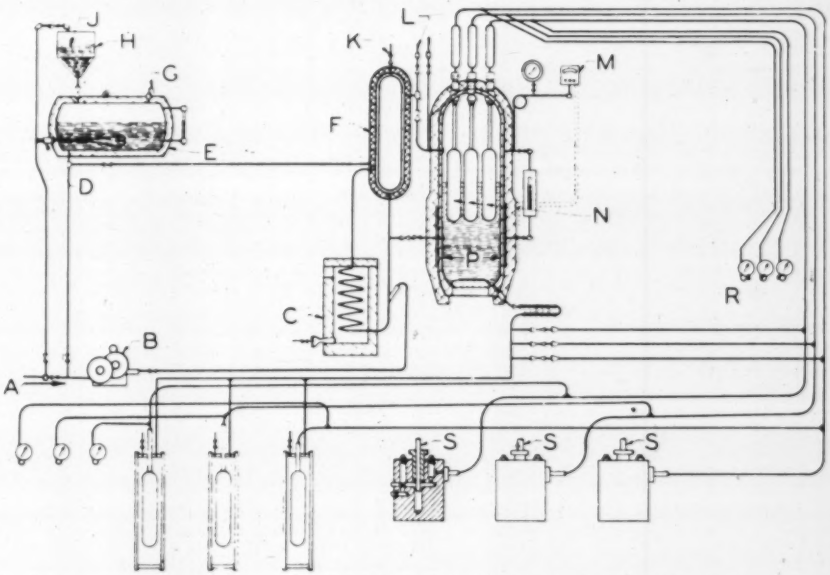
In the earlier stages, experimental stress analysis was conducted by means of Berry strain gages and somewhat later by using DeForest Scratch gages. These tools were later replaced by the Baldwin-Southwark S-4 gages. This paper, therefore, deals largely with the development and the technique employed for experimental stress analysis starting with the use of the SR-4 gage.

Besides the use of SR-4 gages which tell the designer what stress levels are reached in the various parts of the structure under internal pressure, other methods for determining stress concentrations were employed, such as room temperature and high-temperature fatigue tests. The room-temperature fatigue tests were conducted on full-size drums and the high-temperature fatigue test on scale-model cylindrical specimens. The room-temperature full-size drums were subjected to hydraulic pulsations by means of apparatus specially built for this purpose. The high-temperature specimens were placed inside of a steam drum in an atmosphere of saturated steam and water and were similarly tested by means of hydraulic pulsations. The methods used in this kind of testing and the special apparatus built for this purpose are described.

Analysis of Experimental Data Regarding Certain Design Features of Pressure Vessels, by Glen J. Schoessow and Ernest A. Brooks, The Babcock & Wilcox Company, Barberton, Ohio. 1949 ASME Fall Meeting paper No. 49—F-19 (mimeographed).

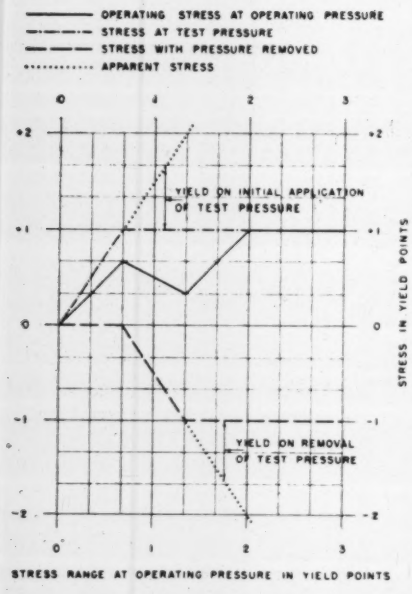
This paper presents an analysis of data obtained by strain-gage experimental stress analysis on drum heads and nozzle openings in drum shells. This analysis, while referred particularly to power boilers, is also applicable to other types of pressure vessels.

The data obtained is reduced to dimensionless form so that it may be applied to drums of other size and thickness but



A- FROM ZEOLITE TANKS
B- HIGH PRESSURE FEED PUMP
C- GAS FURNACE AND PREHEATER COIL
D- I-A 387 CALROD IMMERSION HEATER
E- DEAERATOR TANK
F- PREHEATER HEADER 11 3/4" OD x 4'-0" LONG
G- RELIEF VALVE SET AT 5 P.S.I
H- RECEIVING FUNNEL
J- ZEOLITE WATER
K- VENT
L- SAFETY VALVES
M- PRESSURE CONTROLLER
N- FATIGUE SPECIMENS 6" ID x 3/8" THK.
P- 24" ID x 1 9/32" THK.
R- PRESSURE GAGES
S- PLUNGER BLOCKS OF TRIPLEX PUMP

DIAGRAMMATIC ARRANGEMENT OF HIGH-TEMPERATURE FATIGUE TEST APPARATUS


OPERATING STRESS AT OPERATING PRESSURE
STRESS AT TEST PRESSURE
STRESS WITH PRESSURE REMOVED
APPARENT STRESS
YIELD ON INITIAL APPLICATION OF TEST PRESSURE
YIELD ON REMOVAL OF TEST PRESSURE
STRESS IN YIELD POINTS
STRESS RANGE AT OPERATING PRESSURE IN YIELD POINTS

BEHAVIOR OF VESSEL AT LOCALLY HIGH STRESSED POINTS WITH 150 PER CENT PRESTRESS.

geometrically similar, and to more clearly illustrate the action of the drum in resisting pressure.

The relationship between operating stress level and the life of the vessel in service is discussed with particular reference to a drum that has given more than 40 years of satisfactory service with an operating stress range over a considerable area of the vessel of approximately the ultimate strength of the material.

The effect of prestress created in the vessel by overpressurizing, such as applying the one and one-half times working pressure hydrostatic test, is discussed.

The results of many experimental stress analyses of boiler drums are given in a form permitting their ready application to other vessels of the same general shape.

The significance of these results is discussed with particular reference to allowable stress levels in design. It is shown that in power-boiler service there is no selective corrosive. It is also shown that present design rules are not correct as regards dished heads and reinforced openings.

Wood Technology

Recent Developments in Resinous Wood Adhesives, by R. P. Hopkins and H. Grinsfelder, Rohm & Haas Company, Philadelphia, Pa. 1949 ASME Wood Industries Meeting paper No. 49—WDI-4 (mimeographed).

Ureas continue to be by far the largest selling resinous wood adhesives. Both powdered and liquid forms of the urea-formaldehyde class are receiving attention. Types have been made available which for all practical purposes may be considered dustless. Another improvement introduced recently is the use of catalyst incorporated resins. Large-scale blending of resin-catalyst during resin manufacture, with subsequent control testing, provides an excellent guarantee against the errors possible in selecting and weighing proper quantities of the right hardener in plywood plants. Another improvement is better initial water and flour dispersibility.

Current innovations in liquid urea resin adhesives lie in attempts to obtain more stable syrups. Thus far only straight urea-formaldehyde resins have been considered. Two important variations of these resins are extending the usefulness of the synthetic nitrogen adhesives: (1) melamine modified ureas for hot-pressed plywood, and (2) special ureas, e.g., furfuryl modified, for more foolproof assembly gluing.

Primary recent interest in phenolic developments has been directed toward obtaining fast-curing phenolics for the hardwood industry.

Wood adhesives based on polyvinyl acetate emulsions had a skyrocketing development in 1946 and 1947.

Fundamentals of Adhesion, by G. M. Kline, Mem. ASME, and F. W. Reinhart, National Bureau of Standards, Washington, D. C. 1949 ASME Wood Industries Division Meeting paper No. 49—WDI-5 (mimeographed).

The most significant factor in adhesion is the molecular attraction operative between the adherend and the adhesive. There are many physical factors which affect the strength of a bond by determining the closeness of contact of the adherend and adhesive, by altering the surface area involved, or by influencing the stress conditions in the joint either as initially formed or under external loading. Although some of the strength of a bond between an adhesive and a porous surface can be attributed to tendrils of adhesive which enter the pores, this mechanical interpenetration cannot account for more than a small fraction of the joint strength. Evidence has accumulated from many pertinent fields which indicates that molecular attractive forces are primarily responsible for the bond between any two surfaces.

The types of chemical bonds involved in specific adhesion are reviewed in this paper, and various physical factors which affect bond strengths are discussed.

In considering the chemical and physical phenomena involved in adhesion and cohesion, four general types of chemical bonds are described: electrostatic, covalent, and metallic, which are referred to as primary valence bonds, and residual bonding attraction forces, commonly known as van der Waals forces, which are referred to as secondary valence bonds.

ASME Transactions for October, 1949

THE October, 1949, issue of the Transactions of the ASME contains:

Calibration of Eccentric and Segmental Orifices in 4 and 6-In. Pipe Lines, S. R. Beitler and D. J. Masson (48—A-149)

Critical Flow Through Sharp-Edged Orifices, J. A. Perry, Jr. (48—A-146)

Air Flow Through Small Orifices in the Viscous Region, H. R. Linden and D. F. Othmer (48—A-93)

Reaction Tests of Turbine Nozzles for Supersonic Velocities, J. H. Keenan (48—A-61)

Reaction Tests of Turbine Nozzles for Subsonic Velocities, H. Kraft (48—A-59)

The Instron Tensile Tester, H. Hindman and G. S. Burr (48—A-68)

Heat Transfer to Liquid Metals Flowing in Asymmetrically Heated Channels, W. B. Harrison and J. R. Menke (48—A-51)

Heat Transfer to Water at High Flux Densities With and Without Surface Boiling, F. Kreith and M. Summerfield (48—A-38)

A Ventilated Thermal-Insulation Structure for High-Temperature Marine Power Plants, A. L. London and C. R. Garbett (48—A-46)

The Mechanical Cleaning of Fouled Heat-Exchanger Tubes, A. John (48—A-114)

Chemical Cleaning of Heat Exchange Equipment, C. M. Loucks and C. H. Groom (48—A-113)

Scale Formation and Control in Compression Distillation of Sea Water, J. J. Campobasso and A. Latham, Jr. (48—A-115)

Cleaning Tubular Heat Exchangers, P. F. Dougherty and C. H. Brooks (48—A-116)

Fouling Rates and Cleaning Methods in Refinery Heat Exchangers, R. C. Butler and W. N. McCurdy, Jr. (48—A-117)

Rates of Fouling and Cleaning of Unfired Heat-Exchanger Equipment, J. H. Weiland, Jr., R. C. McCay, and J. E. Barnes (48—A-112)

Fouling of Marine-Type Heat Exchangers, H. E. Bethon (48—A-145)

The Fouling and Cleaning of Surfaces in Unfired Heat Exchangers—Panel Discussion Prepared by O. P. Bergelin

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Analytical Mechanics of Gears

ANALYTICAL MECHANICS OF GEARS. By Earle Buckingham. McGraw-Hill Book Co., New York, N. Y., Toronto, Canada, and London, England, 1949. Cloth, 5¾ × 9 in., figs., tables, ix and 546 pp., $10.

Reviewed by PAUL H. BLACK[1]

THE BOOK under review is destined to become a stimulus to the development and application of the science of gearing, comparable to that of the treatise "Steam and Gas Turbines" by A. Stodola, in the development of the steam and gas turbine. The comparison has significance when one considers the vast development of the turbine during the last fifty years and that today the major part of the power generated by prime movers is transmitted by gears.

The full advantage of the properties of the involute curve is not always utilized in gearing because the method of calculating involute sizes and proportions is not generally known. In this treatise the fundamental relationships and methods are developed, and the basis is laid for effective design of all types of gears.

The first seventeen chapters are devoted to an analysis of conjugate gear-tooth action, and to a study of the nature of the resulting gear-tooth profiles for all types of gearing. Conjugate gear-tooth action is defined as action between gear teeth that transmit through each other uniform rotary motion.

Four of these chapters cover "involutometry" of spur, internal, helical, and spiral gears. By involutometry is meant the process of calculating the relationships of involute curves, and requires a calculating machine if much work is to be done.

Among the topics in the first section of the book are those on limits of conjugate action in gear teeth; trochoids, fillets, and undercuts; and in worm gears, helicoidal sections, and path and field of contact. The relation between the gear cutter and the resulting gear is developed for most types of gears. The treatment for each phase of the work is carried through for spur gears, internal gears, helical gears, spiral gears, bevel gears, hypoid gears, and worm gears. Many of the analytical solutions are new and hitherto have not been published. The treatment throughout is replete with definite practical examples worked out to illustrate applications of the principles and methods.

The last seven chapters in the book give an analysis of the physical action of gear teeth which includes the nature and influence of friction, heat generation and dissipation, and the resistance of gear teeth to breakage and wear. Of particular interest is the new method for determining the approximate value of the dynamic loads on gear teeth for all types of gears, with discussion of the influence of fine pitch and high speeds.

This section is of special value to designers and contains hitherto unpublished information which if wisely used by the gearing industry should enhance the value and service of its product to meet demands for greater loads, higher speeds, and better performance in reliability and quietness.

The author states that this material may be regarded as the "final report of the ASME Special Research Committee on Worm Gears and the Strength of Gears." On mechanical design and development engineers rests the responsibility for its most advantageous use, and this carries with it the necessity for mastery of the treatment in the first seventeen chapters of the book. As the author puts it, this is not a text in gear design, but should form a sound foundation upon which logical design data can be erected.

This treatise by Professor Buckingham stands to be the outstanding work of this century in the field of gearing, and will take its place as one of the important published works in the field of mechanical engineering.

[1] Professor of Mechanical Engineering, Chairman, Department of Mechanical Engineering, Ohio University, Athens, Ohio. Mem. ASME.

The Watts Bar Steam Plant

THE WATTS BAR STEAM PLANT: A Comprehensive Report on the Planning, Design, Construction, and Initial Operation of the Watts Bar Steam Plant. Technical Report No. 8. U. S. Tennessee Valley Authority. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 1949. Buckram, 5¾ × 9 in., 67 illus., 15 tables, 56 exhibits, $2.25.

REVIEWED BY H. WEISBERG[2]

THIS report covers the planning, design, construction, and initial operation of the Tennessee Valley Authority Watts Bar Steam Plant. It is one of a series of technical volumes published by the Tennessee Valley Authority describing its various power projects. Included is a comprehensive summary of the project costs; a complete statistical summary of physical features; a list of major purchases of material and equipment, and 56 selected drawings comprising general plans of yard, structures, and equipment; mechanical and electrical installations (including coal-handling and storage equipment); and system control diagrams.

It is unfortunate that the report could not have been published earlier. Steam-power-plant equipment is commonly evaluated on the basis of a 20-year life; it being assumed that at the end of this period new developments and changing conditions will have resulted in the design becoming obsolete. Making available a description of a 1940 design in 1949 detracts considerably from its usefulness. The completeness of the report, however, somewhat offsets its tardiness; there probably never before having been published a description of a steam-power-plant project which is quite so complete. It will therefore undoubtedly be of interest to many, not only in this country but throughout the world.

While on the whole the reasons given for the selection of type of plant and equipment appear sound, it is to be regretted that more extensive evaluations were not made to determine optimum size of units, steam conditions, efficiencies of equipment, condenser size, and feedwater-heating cycle, etc. Exact determi-

[2] Mechanical Engineer, Electric Engineering Department, Public Service Electric & Gas Co., Newark, N. J. Mem. ASME.

nation of these variables is not subject to rational solution because so much depends on the assumptions made, but a certain amount of evaluation is helpful in arriving at a satisfactory selection. The inference is that demands of the National Defense Program at the time the plant was authorized did not permit detailed studies.

A word of caution is advisable regarding the reported costs of the installation. The power-plant construction cost index has increased about seventy-five per cent since this installation was made. Reported figures should therefore be adjusted accordingly for present-day use.

Books Received in Library

ASTM STANDARDS ON LIGHT METALS AND ALLOYS, sponsored by ASTM Committee B-7 on Light Metals and Alloys, Cast and Wrought, February, 1949. American Society for Testing Materials, Philadelphia, Pa., Paper, 6 × 9 in., 150 pp., diagrams, charts, tables, $2.25. (ASTM members, $1.75.) This publication includes specifications and methods of test on light metals and alloys, both cast and wrought. Also included are specifications for aluminum wire and cable for electrical purposes, several methods of chemical analysis, and a specification for aluminum and aluminum-alloy arc-welding electrodes.

ASTM STANDARDS ON RUBBER PRODUCTS (with Related Information), prepared by ASTM Committee D-11 on Rubber Products; Methods of Testing, Specifications, February, 1949. Paper, 6 × 9 in., 564 pp., illus., diagrams, charts, tables. American Society for Testing Materials, Philadelphia, Pa., $4.50. (ASTM members, $3.40.) Of interest to rubber technologists, sales engineers, and all concerned with the purchase of rubber products, this publication presents in convenient form for laboratory use and reference the various ASTM standard and tentative methods of test and specifications pertaining to rubber products. Two proposed methods are also included.

ANALYTICAL MECHANICS OF GEARS. By E. Buckingham. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1949. Cloth, 6 × 9¼ in., 546 pp., diagrams, charts, tables, $10. This book is an advanced and thoroughly definitive treatise on analytical mechanics of gears with a purely mathematical and analytical approach. It is not a text on the design of gears but a source book providing an outline of all the fundamental relationships that form the foundation of the design of all types of gears. The first chapters give an analysis of conjugate gear-tooth action, nature of the contact, and resulting gear-tooth profiles of the several types of gears. The later chapters give analyses of gear teeth in action. Diagrams and tables illustrate and amplify the text material.

BERKELEY SYMPOSIUM ON MATHEMATICAL STATISTICS AND PROBABILITY, PROCEEDINGS, held at the Statistical Laboratory, Department of Mathematics, University of California, August 13–18, 1945, January 27–29, 1946. Edited by J. Neyman. University of California Press, Berkeley and Los Angeles, Calif., 1949. Cloth, 6½ × 10½ in., 501 pp., diagrams, charts, tables, $7.50. Containing thirty papers written by noted scholars and mathematicians, this book covers applications of mathematical statistics and probability to philosophy, astronomy, economics, agriculture, biology, forestry, psychology, and entomology. Some papers are limited to the presentation of experimental problems requiring statistical treatment. In others statistical theory is important as a tool used to clarify some complex phenomena. Bibliographies, generally brief, accompany many of the papers.

CONSTRUCTIVE USES OF ATOMIC ENERGY. By S. K. Allison and others, edited by S. C. Rothmann. Harper & Brothers, New York, N. Y., 1949. Cloth, 5½ × 8¼ in., 258 pp., illus., diagrams, charts, tables, $3. This volume brings together fourteen articles by specialists describing the current uses of atomic energy in the fields of industrial power, chemistry, metallurgy, aviation, ceramics, soil-fertilizer research, biology and medicine, and pointing out the possibilities of future development. An appendix contains a glossary, a classified bibliography, and a chronological list of significant dates.

CONVEYERS AND RELATED EQUIPMENT. By W. G. Hudson. Second edition. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, Ltd., London, England, 1949. Leather, 6 × 9¼ in., 468 pp., illus., diagrams, charts, tables, $7. This comprehensive treatment of the science of handling materials describes the application of a wide variety of equipment and analyzes the several kinds from the viewpoint of effectiveness. It provides a guide to the factors which must be considered when buying, equipping, operating and maintaining conveyers and related devices. The new edition contains an extended discussion of pneumatic conveying.

ELEMENTS OF DIESEL ENGINEERING. By O. L. Adams. Second edition. Norman W. Henley Publishing Co., New York, N. Y., 1949. Fabrikoid, 5½ × 8¼ in., 367 pp., illus., diagrams, charts, tables, $5. This basic book on Diesel engines has been considerably revised to conform with modern practice. It begins with chapters considering terminology, mathematics, and fundamental engine cycles. Succeeding chapters deal with fuel-injection systems; combustion and heat distribution; rating, testing, and performance; air intake and supercharging. Interpretation of Diesel indicator diagrams, Diesel fuel and lubricating oils, fuel properties, and engine performance are also discussed.

ENGINEERING ECONOMICS AND PRACTICE, INCLUDING SOLUTIONS TO PROBLEMS IN PROFESSIONAL ENGINEER EXAMINATIONS, NEW YORK STATE. By M. J. Steinberg and W. Glendinning. Apply W. Glendinning, 5123 Bell Boulevard, Bayside, N. Y., 1949. Paper, 8½ × 11½ in., 101 pp., diagrams, charts, tables, $3. This book covers the basic principles of engineering economics and practice. The principles have been reduced to a formula basis with each of the terms clearly defined. Each chapter includes problems of a practical nature that illustrate the principles involved. Questions and solutions to the problems in engineering economics and practice from the New York State professional-engineering examinations are an important supplement to the text material.

FÜHRER DURCH DIE STRÖMUNGSLEHRE. By L. Prandtl. Third edition, revised and enlarged. Friedrich Vieweg & Son, Braunschweig, Germany, 1949. Stiff cardboard, 407 pp., illus., diagrams, charts, tables, 16 D m. ($5.30, Hafner-Stechert, New York, N. Y.) This treatise on the flow of fluids is intended to provide a comprehensive and easily understandable account of the subject, in which the mathematical treatment is held to a minimum. The new edition has been enlarged and revised with the intent to provide a more scholarly work.

HYDRO-ELECTRIC ENGINEERING. By G. Gerard. Sir Isaac Pitman & Sons, Ltd., London, England, 1949. Cloth, 5½ × 8¾ in., 181 pp., illus., diagrams, charts, maps, tables, 20s. Written from the practical angle, this book outlines the civil, mechanical, and electrical aspects of hydroelectric engineering. To illustrate certain of the principles touched on, an appreciable space is devoted to descriptions of typical hydroelectric plant and schemes in operation in various parts of the world.

INDUCTION HEATING. By N. R. Stansel. McGraw-Hill Book Co., New York, N. Y., Toronto, Canada, London, England, 1949. Cloth, 6 × 9¼ in., 212 pp., illus., diagrams, charts, tables, $3.50. Supported by measurements to provide a factual basis, this book presents the electrical and thermal principles of the use of eddy currents for industrial heating service. It shows how these principles are applied in practice and indicates the procedures for the development of new uses of this method of heating. The examples cover the entire range of practice in the heating of metals and metal parts.

INTRODUCTION TO STATISTICAL MECHANICS. By R. W. Gurney. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1949. Cloth, 6¼ × 9¼ in., 268 pp., diagrams, charts, tables, $5. Intended for use by graduate students of physics and chemistry, this book studies the behavior of large groups of particles. It shows how the behavior of matter in bulk follows directly from the properties of individual atoms. There is an unusual development of the principles of partition functions followed by their applications. A feature is the treatment of metallic alloys. Problems appear at the end of each chapter.

INTRODUCTION TO THE THEORY OF FOURIER'S SERIES AND INTEGRALS. By H. S. Carslaw. Third edition, revised and enlarged. Dover Publications, Inc., New York, N. Y., 1949. Cloth, 5½ × 8¼ in., 368 pp., diagrams, charts, tables, $3.95. This book is a reprinting of a standard mathematical treatise which has been out of print for some three years. There is a historical introduction as well as a detailed treatment of the fundamentals of mathematical physics.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquires to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

DIE KREISELPUMPEN FÜR FLÜSSIGKEITEN UND GASE. By C. Pfleiderer. Third edition. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1949. Paper, 6 × 9 in., 518 pp., illus., diagrams, charts, tables, 54.60 Dm. This well-known work on centrifugal pumps has again been considerably revised and enlarged to include the latest results of hydrodynamic research and practice. A comprehensive review of both theory and design, the book is well suited to the needs of practicing engineers.

MANUFACTURE OF IRON AND STEEL. Vol. 1, Iron Production. By G. R. Bashforth. Chapman & Hall, Ltd., London, England, 1948. Cloth, $5\frac{1}{2} \times 8\frac{3}{4}$ in., 228 pp., illus., diagrams, charts, tables, 21s. This first volume of a two-volume textbook set deals comprehensively yet simply with modern iron production. Beginning with an account of iron ores and their occurrence, it continues with a discussion of the functions of a blast furnace and the preparation of iron ores. Chapters follow on all aspects of blast-furnace design and operation. Electric reduction furnaces and special iron alloys are also treated. A short bibliography follows each chapter.

MATHEMATICAL FOUNDATIONS OF STATISTICAL MECHANICS. By A. I. Khinchin. Dover Publications, New York, N. Y., 1949. Cloth, $5 \times 7\frac{1}{2}$ in., 179 pp., tables, $2.95. Translated from the Russian, this book offers a precise and mathematically satisfactory formulation of the problems of statistical mechanics, and provides the analytical tools needed to replace many of the cumbersome concepts and devices commonly used for establishing basic formulas.

MATERIALS OF CONSTRUCTION, WOOD, PLASTICS, FABRICS. By A. G. H. Dietz. D. Van Nostrand Co., Inc., Toronto, Canada, New York, N. Y., London, England, 1949. Linen, $6\frac{1}{4} \times 9\frac{1}{4}$ in., 347 pp., illus., diagrams, charts, maps, tables, $4.50. In this book stress is given to the essential nature of the materials discussed and to the development of their applications from those basic attributes. The properties and uses of wood, plastics, and fabrics are discussed separately as well as in circumstances where they are used in combinations. Composite materials are treated in the final chapter. Selected bibliographies follow each chapter.

MODERN DIESEL, edited by G. G. Smith, revised and rewritten by D. H. Smith. Eleventh edition. Iliffe & Sons, Ltd., London, Birmingham, Coventry, Manchester, England, and Glasgow, Scotland, 1949. Cloth, $4\frac{1}{4} \times 7$ in., 277 pp., illus., diagrams, charts, tables, 7s 6d. Diesel theory, fuel-injection systems, cylinder-head design, fuel, and lubricants are dealt with in the first half of the book. The remainder is devoted to specific descriptions of engines in current production in Great Britain, the United States, and the major producing countries in continental Europe. Engines for highway, railway, marine, and aircraft service are covered.

MODERN PLASTICS ENCYCLOPEDIA, 1949. Plastics Catalogue Corporation, New York, N. Y. Fabrikoid, $8\frac{1}{4} \times 11\frac{3}{4}$ in., 1371 pp., illus., diagrams, tables, $5. The 1949 edition emphasizes significant applications of plastic materials by grouping them in a new section. The plastic products selected are described and illustrated in twenty-seven articles, each covering a major industrial field. In the Technical Data Section there is a new article surveying the properties of plastics. Used in conjunction with the Plastics Properties Chart, this article together with some 300 references gives complete data on the properties of commercial plastics. The twelve annually revised charts, with the exception of the Plastics Properties Chart, have been incorporated in page form in the Technical Data Section.

MODERN RAILROAD STRUCTURES. By C. P. Disney and R. F. Legget. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1949. Cloth, $7\frac{1}{4} \times 10\frac{1}{4}$ in., 213 pp., illus., diagrams, charts, tables, $5. This book is an illustrated record of some of the recent advances in the design and construction of the more important structures required for railroads. The importance of soil mechanics in railroad engineering is stressed, modern methods of treating railroad track are described, and recent improvements in the art of grouting and repairing concrete and masonry work are fully covered. Extensive treatment is given to bridge types.

MODERN TIMBER ENGINEERING. By W. F. Scofield and W. H. O'Brien. Third edition. Southern Pine Association, New Orleans, La., 1949. Fabrikoid, $6 \times 9\frac{1}{4}$ in., 147 pp., diagrams, charts, tables, $1.50. Intended both as a textbook for students and a reference book for practicing architects and engineers, this publication deals with the characteristics of wood, fastenings, beams, columns, trusses, floor systems, and other pertinent topics. Diagrams, worked-out examples, and data tables add to the practical value of the work. Specifications conform to standard building codes.

PHYSICAL PRINCIPLES OF GAS LIQUEFACTION AND LOW TEMPERATURE RECTIFICATION. By M. Davies. Longmans, Green & Company, London, England, New York, N. Y., Toronto, Canada, 1949. Cloth, 6 × 10 in., 205 pp., diagrams, charts, tables, 25s. This book discusses all the fundamental aspects of gas liquefaction and the fractional distillation of liquefied gases. It covers the different processes now used industrially. Processes are considered which extract chemically valuable gases from any industrially significant source and which use most effectively coal and petroleum.

PRÜFEN UND MESSEN DER OBERFLÄCHENGESTALT. By J. Perthen. Carl Hanser Verlag, Munich, Germany, 1949. Fabrikoid, $6\frac{1}{2} \times 9\frac{3}{4}$ in., 257 pp., illus., diagrams, charts, tables, 25 Dm Kart., 28 Dm bound. Volume 3 of a series of technical measurements, this book deals with surface conditions, with methods and apparatus for testing and measuring surfaces, with the practical application of surface measurement and its relation to interchangeable manufacturing. A bibliography of some 950 references is included.

RULES FOR THE CONSTRUCTION, TESTING AND SCANTLINGS OF METAL-ARC-WELDED STEEL BOILERS AND OTHER PRESSURE VESSELS. Associated Offices Technical Committee, National Buildings, Manchester, England. Leather, $4\frac{1}{2} \times 6\frac{1}{2}$ in., 40 pp., diagrams, charts, tables, 5s. This small volume has been issued to provide in compact form information with regard to the design and construction of a wide variety of welded steel boilers and pressure vessels with the intention of encouraging the production of sound vessels using the minimum amount of steel.

OIL HYDRAULIC POWER AND ITS INDUSTRIAL APPLICATIONS. By W. Ernst. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1949. Cloth, $6 \times 9\frac{1}{4}$ in., 366 pp., illus., diagrams, charts, tables, $6. Designed to meet the needs of the practicing engineer, this book covers development, theory, and practical applications. It gives detailed sample calculations and designs for hydraulic components, pumps, and valves. The first part deals with fundamentals and the second with the generation of oil hydraulic power, its utilization, control, and transmission.

PETROLEUM PRODUCTION, Volume 5. Oil Production by Gas and Flooding. By P. J. Jones. Reinhold Publishing Corporation, New York, N. Y., 1948. Cloth, $6 \times 9\frac{1}{4}$ in., 274 pp., charts, tables, $6. This is the fifth and concluding volume of a series reviewing the economics of petroleum production. Following a thorough review of reservoir characteristics and other fundamentals, the problems of oil production by gas and flooding are analyzed in detail. Charts and tables are extensively used to illustrate or summarize the text material.

SCAVENGING OF TWO-STROKE-CYCLE DIESEL ENGINES. By P. H. Schweitzer. The Macmillan Company, New York, N. Y., 1949. Cloth, $7\frac{1}{2} \times 10\frac{1}{4}$ in., 268 pp., illus., diagrams, charts, tables, $7.25. The purpose of this book is to make it easier to design better two-stroke cycle diesel engines. It gives a full treatment of the scavenging operation and of port design. Avoiding complex mathematics and complicated formulas, the author uses charts readily applicable to design problems. A bibliography and a discussion of scavenging terminology are included.

STAINLESS STEELS. By C. A. Zapffe. American Society for Metals, Cleveland, Ohio, 1949. Fabrikoid, $6 \times 9\frac{1}{4}$ in., 368 pp., illus., diagrams, charts, tables, $5. Intended as an elementary text for consumers, this book describes the fundamentals of stainless steel. Only a smattering of metallurgy and a real interest in the subject are required. Wrought alloys and corrosion resistance are the principal subjects covered. A glossary and a selected bibliography are included.

STRUCTURAL DESIGN IN METALS. By C. D. Williams and E. C. Harris. Ronald Press Co., New York, N. Y., 1949. Cloth, $6 \times 9\frac{1}{2}$ in., 596 pp., illus., diagrams, charts, tables, $6.50. Intended for use as a text for engineering students in their junior year, this book considers the design of details rather than complete structures. Rivets, welds, plate girders, srusses, bearings, and rigid frames are considered in detail, as well as the selection of tections. The appendix contains relevant specifications from various technical societies.

SYMPOSIUM ON AGING OF RUBBERS (Special Technical Publication No. 89.) Chicago Spring Meeting, American Society for Testing Materials, March 2, 1949. American Society for Testing Materials, Philadelphia, Pa., 1949. Cloth and paper 6×9 in., 72 pp., illus., diagrams, charts, tables, paper, $1.75; cloth, $2.40. This symposium contains six papers by leading authorities, giving an exhaustive review of the various methods for accelerating the aging of natural rubber and synthetic elastomers.

TECHNICAL DRAWING. By F. E. Giesecke, A. Mitchell, and H. C. Spencer. Third edition. The Macmillan Company, New York, N. Y., 1949. Cloth, $6\frac{1}{4} \times 9\frac{1}{2}$ in., 851 pp., illus., diagrams, charts, tables, $4.50. Intended as a class text and reference book in technical drawing, this volume contains a large number of problems covering every phase of the subject. It uses the "language of the engineer" and includes the latest developments in industry. In this edition, a large part of the text matter is rewritten, and a number of new illustrations and problems are

added. The book has been brought into agreement with the latest standards of the American Standards Association.

TWO LECTURES: (1) Present Situation in the Theory of Elementary Particles. (2) Electron Theory of Superconductivity. By W. Heisenberg. University Press, Cambridge, England; American Branch, New York, N. Y., 1949. Cloth, $4^3/_4 \times 7^1/_2$ in., 52 pp., diagrams, $1. The two lectures presented in this volume were delivered at the Cavendish Laboratory. In the first lecture the author tries to explain why the well-known divergencies in meson theory and nuclear physics may be considered as a natural feature of the present 'correspondence' theory. The second lecture deals with an application of quantum mechanics, the theory of superconductivity.

VISCOMETRY. By A. C. Merrington. Longmans, Green & Co., Inc., New York, N. Y., Edward Arnold & Co., London, England, 1949. Cloth, $5^1/_2 \times 8^3/_4$ in., 142 pp., illus., diagrams, charts, tables, $4.50. Written for the practical research worker, this book gives a concise up-to-date account of most of the methods available for measuring viscosity, with some reference to their advantages and limitations. A bibliography is included.

WORLD TOUR IN OIL. By A. M. Leeston. Apply to Dr. Alfred M. Leeston, 1000 Continental Building, Dallas, Texas, 1948, reprinted 1949. Paper, 6 × 9 in., 35 pp., illus., diagrams, maps, tables, $0.50. Condensed factual and statistical information is given on an oil-producing countries and areas. The information varies from thumb-nail descriptions of the several countries to drillers' notes on common depths for finding oil.

ASME BOILER CODE

Extended Considerations for Basing Tables P-7 and U-2

To differentiate between past and present practice in establishing allowable working stresses for materials listed in Tables P-7 and U-2 of the Boiler Construction Code, the Subgroup on Stress Allowance for Ferrous Materials has formulated the two following statements:

Basis on Which Allowable Working Stresses in Tables P-7 and U-2 *Have Been* Established

The tables of allowable stresses are grouped according to temperature and in every case the temperature is understood to be the *actual metal temperature*.

The stresses given in Tables P-7 and U-2 are based on 20 per cent of the minimum tensile strength according to specifications, except for bolting materials. For bolting materials the design stress is based on 16 per cent of the minimum tensile or 20 per cent of the yield strength for 0.2 per cent offset, whichever is lower. (It is recognized that bolts are always expected to work at stresses above the design value as distinguished from other parts.)

The stress values are based on 80 per cent of the stress to produce a creep rate of 1/100 per cent per 1000 hours. Since 1944 stress-rupture data when available have been given consideration on the basis that the allowable stress should not exceed 50 per cent of the stress to produce rupture at the end of 100,000 hours. However, it turns out that the creep data, during the interval have been the limiting consideration. It should be noted that stresses set prior to 1944 have not been readjusted to meet the stress rupture criterion.

In the choice of stresses in the range when a per cent of T.S. or Y.S. governs, it is presumed that materials will be no better than given in the specification and no credit is allowed for any improvement in tensile properties by special heat-treatment.

In the transition range between where 20 per cent of the tensile strength governs and where 80 per cent of the stress to produce a creep rate of 1/100 per cent per 1000 hours governs, allowable working stresses shall not exceed 50 per cent of the yield strength for 0.2 per cent offset.

Recommended Basis for Establishing Allowable Working Stresses for Tables P-7 and U-2

The tables of stresses are grouped according to temperature, and in every case the temperature is understood to be the *actual metal temperature*.

In the determination of tabular stresses, the Subgroup on Stress Allowances for Ferrous Materials is guided by successful experience in service with the particular steels in question in so far as evidence of satisfactory performance is available, such evidence being preferred to all forms of test data. However, in the evaluation of new materials, it is always necessary to be guided to a certain extent by the comparison of test information with similar data on successful equipment and in carrying out this process of examination and evaluation, the Subgroup finds the following considerations useful.

At lower temperatures the stresses given in Tables P-7 and U-2 for wrought and cast materials are based on 20 per cent of the minimum tensile strength according to specifications, except for bolting materials. For bolting materials the stress is based on 16 per cent of the minimum tensile strength or 20 per cent of the yield strength for 0.2 per cent offset, whichever is lower. (It is recognized that bolts are always expected to work at stresses above the design value as distinguished from other parts.)

At higher temperature the stresses are based on 80 per cent of the stress to produce a creep rate of 1/100 per cent per 1000 hours, greater weight being given to longer time tests in evaluating data. The Subgroup believes that long time stress rupture test data should be given careful consideration in setting stresses within the creep range. Therefore, the long time rupture strength of materials at high temperature will be given an increasing weight in the choice of working stresses. In addition to the above stated creep stress requirement, new values added to the Table will in future not exceed 100 per cent of the stress to produce rupture at the end of 100,000 hours.

In the choice of stresses in the range where a per cent of T.S. or Y.S. governs, it is presumed that materials will be no better than given in the specification, and no credit is allowed for any improvement in tensile properties by special heat-treatment.

In the transition range between where 20 per cent of the tensile strength governs and where 80 per cent of the stress to produce a creep rate of 1/100 per cent per 1000 hours governs, stresses do not exceed 50 per cent of the yield strength for 0.2 per cent offset.

Errata

CASE No. 1095

Revise last sentence of Reply in MECHANICAL ENGINEERING, July, 1949, page 615 to read:

Because closer control of composition than that required by the approved specification has been found to be effective in preventing significant loss of impact strength at least down to —325 F, the impact tests may be omitted for material that conforms to Grade A of either Specification S.B.-96 or S.B.-98, provided either manganese or phosphorus has been added in an amount necessary for deoxidation and provided iron is not present in an amount in excess of 0.65 per cent and aluminum in an amount in excess of 0.01 per cent, for use at temperatures of —325 F and above.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

Engineers Joint Council Hears Report on Organization of UPADI

THE proposed constitution of the Union of Pan-American Engineering Societies (UPADI) drafted at the First Pan-American Congress held in Rio de Janeiro last July, was taken under consideration by the Engineers Joint Council at its meeting held in the Engineering Societies Building, New York, N. Y., Sept. 16, 1949.

S. S. Steinberg, dean, University of Maryland, who headed the United States delegation to the Congress, urged in his report that American engineers join their colleagues in the western hemisphere "in advancing the knowledge and the application of engineering techniques and to maintain that unity of professional understanding and action necessary to make effective the slogan of the First Pan-American Engineering Congress, namely, Engineering in the Service of Peace."

UPADI Objectives

Some of the objectives of the proposed Union are: To encourage Pan-American conventions and exhibits; to promote individual and collective visits of engineers between member countries; the interchange of teachers, lecturers, and students among engineering schools; and generally to promote understanding among engineers of the western hemisphere.

The constitution is now before engineers of Argentina, Brazil, Canada, Chile, Colombia, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Paraguay, Peru, United States, Uruguay, and Venezuela, all of whom sent representatives to the organization meeting of UPADI. When 15 of the countries approve the constitution, UPADI will be considered established and the first meeting will be held in Havana, Cuba, if that country is a member of the Union by that time.

Dean Steinberg's report was accepted with thanks and was referred to the EJC Committee on International Relations for recommendation. It was the concensus that United States engineering organizations ought to do their part in promoting co-operation among engineers in the Americas.

New EJC Employment Survey Planned

The General Survey Committee, whose report on 1949 employment programs for engineering graduates was published on pages 665-668 of the August issue of Mechanical Engineering, reported that it is contemplating a similar survey to be issued early in 1950.

Concerned over provisions in the Army Reorganization Bills, S-2332 and HR-5794, which are detrimental to the future professional status of engineers in the military service, EJC, through its Committee on National Military Establishment, has prepared a statement for presentation to a Congressional committee when hearings on these bills are scheduled.

EJC is also investigating the possibility of discrimination against professional engineers because of a current classification that places inspectors of construction in the CAF (clerical, administrative, fiscal) class rather than in the P (professional) category. EJC has also been in touch with the chairman of the Civil Service Commission about establishment of an Engineering Advisory Committee to the Civil Service Commission.

B. A. Bakhmeteff, Mem. ASME, chairman of the EJC Committee on Science Legislation, reported that the National Science Foundation legislation in behalf of which EJC has made presentations before Congressional groups, has been held up in the House and would presently not get any attention during this session.

Second London Conference of Engineers Is Held

THE trend toward closer working relationships among the national engineering societies of free nations was given a strong push forward during the week of September 18-25 in London. Advancement of such relationships was the objective and accomplishment of the Second London Engineering Conference.

As was the case at the conference a year ago, the principal national engineering societies of Belgium, Denmark, France, Great Britain, Holland, Norway, Sweden, Switzerland, and the United States were represented in London by their presidents and secretaries, or by their deputies. The Engineers Council of Finland, representing some 4000 professional engineers, was added to the Conference at this meeting and expects to have delegates present at the next meeting of the Conference, which is scheduled for Amsterdam, Netherlands, in 1951. Wm. N. Carey, executive secretary ASCE, Clarence E. Davies, secretary ASME, H. H. Henline, secretary AIEE, represented their respective societies and the Engineers Joint Council at the conference.

The London Conference unanimously adopted as its aims and objectives the development of direct relationships among the participating societies on a basis of mutual understanding for the purpose of aiding in the advancement of engineering science and practice. This aim is to be achieved by advancing the common aims and objectives of the participating societies; by giving all proper support to each participating society within its own country; by acting as a focus of the professional engineering opinion of the participating societies; and by co-operating with international organizations, and supporting and supplementing their work.

Thought was given at the Conference to the existing "Conference of British Commonwealth Engineering Societies," and to UPADI, the newly launched federation of the principal national engineering societies of the countries of the Western Hemisphere, (see page 776, September, 1949, Mechanical Engineering).

Co-operation between these conferences of national engineering groups promises a practical method for obtaining effective international collaboration and mutual understanding among the professional engineers of the world without the cumbersome machinery of a formal constitution, permanent headquarters, secretariat, or dues. It is intended that each society will pay its own way, and be free to withdraw any time its management feels it unprofitable to stay in the Conference. These conferences are business sessions by their management representatives, and on the business of the respective societies.

Canadian Salaries

PREOCCUPATION with salary trends and employment opportunities is by no means limited to American engineers. The Corporation of Professional Engineers, Quebec, Canada, did some surveying of its own recently. The results of this survey, based on usable data from 76 of 96 organizations employing engineers, and from 1150 of the Corporation's 3199 members were compared in *The Engineering Journal* of The Engineering Institute of Canada with those of the survey recently conducted by the General Survey Committee of the Engineers Joint Council. Young Canadian engineers have nothing to be concerned about. While their minimum starting salary is $210, some $40 less than starting salaries in the United States reported by EJC, actual average minimum Canadian salaries 10 years after graduation are $473, or some $60 higher than in the United States.

Apparently many Canadian engineers did not wait upon the surveys to tell them how green was the grass in their backyard because a decreasing number of them are emigrating to the industrial pastures south of the border, or, as *The Engineering Journal* puts it, their young engineers seem to know that "the gilt is coming off the American gingerbread."

Book-Loan Rates Reduced by ESL

MEMBERS of the ASME can now borrow books from the Engineering Societies Library, 29 West 39th Street, New York, N. Y., for only fifty cents a week for each volume borrowed. Formerly the charge was sixty cents. The new rate makes it easier for members to borrow books from the ESL as a two-week loan on one book, or a one-week loan on two books can be paid simply by sending a dollar bill when the material is returned. It is hoped that many members will find it convenient to pay for loans this way as it helps to keep loan charges low by eliminating billing costs.

Inasmuch as the library's material is valuable and much of it is in frequent demand, the Library Board has established the following rules governing the loan of books:

1 Books, including bound serial publications, may be borrowed by any member of a Founder Society, if in good standing and residing in the continental United States or Canada. (Applicants are asked to name their society.)

2 A charge of 50 cents a week or fraction of a week will be made for each volume borrowed.

3 The maximum length of time for any loan is two weeks, not counting time in transit.

4 Members may have as many as three volumes on loan at one time.

5 Return postage and insurance must be paid by the borrower. Members in Canada also pay forwarding postage.

6 Rare books and reference books are lent only after approval of the Library Board.

New Organization to Work for Peace

THE formation of the Society for Social Responsibility in Science was announced recently following a meeting of scientists and engineers at Haverford College, Haverford, Pa.

The aims of the new organization are "to foster throughout the world a . . . tradition of personal moral responsibility for the consequences for humanity of professional activity, with emphasis on constructive alternatives to militarism; to embody in this tradition the principle that the individual must abstain from destructive work and devote himself to constructive work, according to his own moral judgment; to ascertain . . . the boundary between constructive and destructive work, to serve as a guide for individual and group decisions and action; to establish and operate an employment service . . . for those individuals whose convictions necessitate leaving or refusing destructive work; to assist those individuals who suffer economic or legal difficulties because of . . . abstaining from . . . destructive activity."

The first officers are: President, Victor Paschkis, Mem. ASME, director of the engineering research laboratory of Columbia University; vice-president, William F. Hewitt, Jr., Washington, D. C., physiologist at Howard University School of Medicine; and secretary-treasurer, Vincent Cochrane, Middletown, Conn., biologist at Wesleyan University. Elected to the council of the SSRS were Leonard Dart, physicist for American Viscose Corporation, Marcus Hook, Pa.; Theodore B. Hetzel, Mem. ASME, of the engineering faculty at Haverford College; Franklin Miller, Jr., physicist at Kenyon College in Gambier, Ohio; William T. Scott, physicist at Brookhaven National Laboratory, Long Island, N. Y., and at Smith College, Northampton, Mass.; and James G. Vail, Media, Pa., past-president of the American Institute of Chemical Engineers.

Conference Takes Up Problems of Administration of Research

THE problems involved in administration of the unprecedented volume and complexity of research activity in the United States came under discussion recently when 140 directors of government, industry, and university-research programs met for the third successive year at Pennsylvania State College, State College, Pa., Sept. 12–14, 1949.

While the discussions revolved about the central theme, "The Functions of University Research," they touched on the entire gamut of administrative responsibilities confronting the men responsible for beneficial use of the private and public moneys currently being diverted to research activities in the public interest. This year's discussions were, in effect, a continuation of the previous conferences which concentrated on aspects of governmental and industrial research.

Aspects of University Research

Sam Tour, president, Sam Tour and Company, Inc., set off the 1949 discussions by taking up the alleged encroachment of universities which function on a nonprofit basis in the field of industrial research served by the private research laboratories. The function of the university as an instrument for uncovering new knowledge and research as an educational device were covered by F. C. Lindvall, Mem. ASME, chairman, Division of Engineering, California Institute of Technology. Dr. Lindvall expressed the opinion that research which does not meet these prime objectives has no place in the university. As a representative of government agencies, Hugh L. Dryden, Mem. ASME, director of Aeronautical Research, National Advisory Committee for Aeronautics, explained how the government is fostering co-operation on basic research between government and university laboratories.

Advocating early passage of the National Science Foundation Act as a national coordinating agency for American research, L. A. Hyland, vice-president, Bendix Aviation Corporation, went on to characterize the increasing amount of support from federal agencies in the form of grants in aid to research institutions as an interim measure only and not adequate for the national-research job at hand. Mr. Hyland, who as dinner speaker, presented a report on trends in university research, pointed out that the bulk of basic research must be supplied by the universities and must be developed on a much larger scale than possible under current methods of sponsorship.

Dissemination of Information

Speakers during the second day of the conference covered control of university research, dissemination of results, patent policies and methods of evaluating industrial-research projects.

Referring to the difficulty of publishing and disseminating results of university research, speakers touched on problems facing all engineering and learned societies. The unprecedented expansion of literature in many scientific fields is making it impossible for an individual to read and digest all information published in his field. There is a crying need, they said, for some high-speed method of summarizing reports and an interchange service for relevant articles pertaining to specific research among research workers. There is a need also for a basic satisfactory patent policy in the university research field.

The final session was a panel discussion which explored methods of supporting research in universities, the need for new sources of support, and the general problem of financing research within universities from industrial funds.

Annual Forum for Research Ideas

The annual conferences have permitted discussion of mutual problems and the exchange of information on problems encountered by government, industry, and universities in administration of research. The conferences have won the support of research executives because they touch upon the interrelationship of these three groups, a service not provided by the Industrial Research Institute and the Engineering College Research Council, which function as forums for the research problems of industry and universities respectively.

The first three conferences were sponsored by Pennsylvania State College. The 1950 conference will be sponsored by the University of Michigan, Ann Arbor, Mich. I. C. Crawford, dean, School of Engineering, University of Michigan, was named chairman of the 1950 conference. C. G. Worthington, Mem. ASME, and secretary-treasurer of the Industrial Research Institute, will serve as chairman of the advisory committee.

U. S. National Committee for IUTAM Formed

THE U. S. National Committee on Theoretical and Applied Mechanics, recently organized by seven national scientific and engineering societies, was admitted by unanimous consent as an adhering body to the International Union of Theoretical and Applied Mechanics, according to a communication from Dr. J. M. Burgers, secretary of the Union, with headquarters in Delft, Holland.

Member Organizations

Member organizations of the Committee are: Society for Experimental Stress Analysis, American Society of Civil Engineers, American Institute of Chemical Engineers, Fluid Dynamics Section of the American Physical Society, Institute of the Aeronautical Sciences, American Mathematical Society, and The American Society of Mechanical Engineers, which is providing the secretariat.

The charter, which was declared in effect at a meeting at the Engineering Societies Building, New York, N. Y., March 28, 1948, states: the U. S. National Committee on Theoretical and Applied Mechanics will promote theoretical and applied mechanics in the United States, will represent the United States in the International Union of Theoretical and Applied Mechanics, and will carry on such activities as are necessary as an agency of the International Union.

Members of the Committee are: Chairman, Hugh L. Dryden, Mem. ASME, director of Aeronautical Research, National Advisory Committee for Aeronautics; secretary-treasurer, C. E. Davies, secretary ASME. Representatives of member societies, H. W. Emmons, ASME; R. D. Mindlin, SESA; M. G. Salvadori, ASCE; T. B. Drew, AIChE; R. J. Seeger, ABS; N. J. Hoff, IAS; and E. Reissner, AMS. Members at large, Theodor von Kármán, S. Timoshenko, J. C. Hunsaker, and R. von Mises.

The U. S. National Committee grew out of American participation in the Seventh International Congress on Theoretical and Applied Mechanics held in London, April, 1948. The need for some co-ordination of widespread activity in the field of mechanics in the United States prompted the Applied Mechanics Division of the ASME to suggest a permanent organization of various national bodies interested in mechanics to sponsor the U. S. for participation in international congresses and symposiums. Consequently a charter was drafted and discussed at organizational meeting of the U. S. National Committee during the 1948 Annual Meeting of the ASME. Delegates approved a proposed charter for submission to their respective societies. One of the first actions of the Committee at its meeting of May 23, 1949, was to apply for admission to the International Union.

Future Plans

Future plans call for American representation at a collegium on geophysics in 1950, and at a meeting of the IUTAM in Rome. Plans are already under way for an international congress for theoretical and applied mechanics to be held in the United States during 1951.

Meetings of Other Societies

Nov. 6–10, 1949
American Institute of Chemical Engineers, annual meeting, Hotel William Penn, Pittsburgh, Pa.

Nov. 9–12
The Society of Naval Architects and Marine Engineers, 57th annual meeting, Hotel Waldorf-Astoria, N. Y.

Dec. 4–7
The American Society of Refrigerating Engineers, 45th annual meeting, Edgewater Beach Hotel, Chicago, Ill.

Dec. 19–21
American Society of Agricultural Engineers, winter meeting, Stevens Hotel, Chicago, Ill.

Dec. 26–31
American Association for Advancement of Science, annual meeting, all principal hotels in Pennsylvania Station zone, New York, N. Y.

Jan. 9–13, 1950
Society of Automotive Engineers, Inc., annual meeting and engineering display, Hotel Book-Cadillac, Detroit, Mich.

Jan. 18–20
American Management Association, general management meeting, St. Francis Hotel, San Francisco, Calif.

Jan. 18–20
American Society of Civil Engineers, annual meeting, Hotel Commodore, New York, N. Y.

Jan. 23–26
American Society of Heating and Ventilating Engineers, 56th annual meeting, Hotels Adolphus and Baker, Dallas, Texas.

Jan. 30–Feb. 3
American Institute of Electrical Engineers, winter meeting, Hotel Statler, New York, N. Y.

(For Coming ASME Meetings see page 972)

Reserve Officers Attend Conference On Army Research and Development

MORE than 250 reserve officers enrolled in 19 Reserve Research and Development Training Groups in nine states of the Fifth Army Area participated in one of the first Army-wide conferences held to promote proficiency of reserve officers who are scientists and engineers in problems of a military nature.

The two-day conference, sponsored by the Headquarters, Fifth Army, in co-operation with the 5008th Research and Development Group of Chicago, Ill., was held at Fort Sheridan, Ill., August 27–28, 1949.

Technical Services Discussed

The technical program included talks by representatives of the chiefs of the seven Army technical services who explained the current activities and interests of the service in research and development, and talks by representatives of the Logistics Division, General Staff, who described the government's interest in reserve research and development work and the status and development of guiding policies. The inspirational address prepared by Karl T. Compton, head of the Research and Development Board, was presented by Brig. Gen. R. W. Crichlow, Army Secretary on the Board. The balance of the program was designed to enable various groups of officers to get together for the first time for discussions of mutual problems pertaining to administrative activities, regional activities, professional pursuits, and collaboration on research projects.

The experience was gratifying to the engineers who attended because of the high technical level which was maintained. All of the officers except those of the Chicago group were placed on active duty for the conference and received traveling expenses and pay allowance.

The Organized Reserve Research and Development Training Groups were activated by the Army in centers of research throughout the country to promote a more active participation by professional scientist and engineer reserve officers in the Organized Reserve program, to obtain useful results from actual research accomplished in reserve training, and to assure mobilization assignments which will fully utilize the talents of the scientists-reservists. This new army-reserve activity has been developing and crystallizing since early 1948.

Initial Effort a Success

As an initial effort to create within the Army structure a technical event of sufficient engineering interest to stimulate professional men, the conference established a standard which other Divisions of the Armed Forces can emulate.

Unit Commander, Col. Lars Sjodahl, Ordnance Reserve, was general conference chairman. Lieut. Col. S. Musselman, Ordnance Reserve, Mem. ASME, was assistant general chairman.

ESPS Director Talks About Engineering Employment

ALFRED H. MEYER, director of the Engineering Societies Personnel Service, interrupted his chain of interviews recently to reminisce about his experiences and to talk about the work of the ESPS.

Engineering talent, according to Mr. Meyer, is a highly marketable combination of specialized education and industrial experience sought by employers with costs to cut and new products to develop, and freely made available by engineers with careers to attend to.

At least this is the definition that has guided him through 20 years as director of the cooperative nonprofit clearing house for engineering talent established some thirty years ago by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

Through his office at 8 West 40th Street, New York, N. Y., which is a stone's throw from the Engineering Societies Building, he has watched a daily procession of engineers, the young, the overaged, and the ambitious. He has given generously to each of his time and advice, and has received in return a deep understanding of human nature.

Most engineers, Mr. Meyer believes, are not aware of the scale of job-placement service sponsored by the Founder Societies. Since ESPS was created in 1918, more than 100,000 engineers, or a number greater than the combined membership of the Founder Societies, have sought ESPS employment assistance, and of these, some 40,000 engineers have found jobs through ESPS. During these years the engineering profession has been constantly informed of job openings as they have developed in industry through announcements in technical journals and ESPS publications. To employers and engineering graduates alike, ESPS has come to be known as the "clearinghouse for engineering employment."

Asked about the relationship of the Founder Societies to the ESPS, Mr. Meyer leaned back and said quietly, "This office and the work we do is the human side—the conscience—of the Founder Societies. When engineers are in need they come to us. We rejoice and suffer with them. They come as young graduates, anxious and bewildered, seeking their first job in industry, as ambitious young men 10 or 12 years in industry looking for greater responsibility, and as the so-called overage men in their fifties, out of work through no fault of their own.

Problem of the Overaged

"These men are grateful merely for the opportunity to talk to us," Mr. Meyer continued. "Commercial agencies slam doors in their faces. Agencies feel industry does not want them and know that there is no profit in talking to hopeless prospects. The least ESPS can do for these valuable men with fifteen or twenty years of useful service ahead of them is to listen to them and try to convince industry that a challenging situation exists, one that casts a pall over the middle and end years of an engineering career.

"The sad thing is that young graduates rubbing shoulders in our offices with older men are quick to draw their own conclusions and the conclusions are not good. Either young engineers will leave engineering, or if the profession is truly in their blood, sooner or later they will divert some of their talents—in fact, they are already doing it—to protect their own futures in industry.

SOME OF THE 1500 UNEMPLOYED 1949 GRADUATES IN NEW YORK, N. Y., SEEKING EMPLOYMENT THROUGH THE ENGINEERING SOCIETIES PERSONNEL SERVICE

ALFRED H. MEYER, DIRECTOR ESPS, INTERVIEWING A JOB APPLICANT

Service to Industry

"But there is a bright side to this picture," Mr. Meyer said, sitting up again. "We help engineers by providing an unsurpassed placement service to industry. Our job is to save industry time and money and we do it by our nation-wide system of keeping on file in New York, Detroit, Chicago, and San Francisco a file of professional records of 10,000 technical men who are either unemployed or are looking forward to more responsible jobs.

"We keep in touch with 2000 unemployed engineers through our subscription bulletin, 'Positions Available,' published weekly, and with the entire membership of the Founder and affiliated Societies through their monthly journals."

In not more than five days after an employer places a job listing in his office, Mr. Meyer explained, subscribers to the ESPS bulletin know about it and not more than three weeks later 100,000 other engineers see the announcement in the monthly journal of their society. No other employment agency, he claims, gives such rapid and extensive service or has on tap so many qualified technical men. This free service to industry saves employers the expense of advertising in local newspapers, and what is of more importance, the time of screening an avalanche of applications, many of which come from hopelessly unqualified applicants who have misinterpreted the necessarily brief and often ambituous wording in newspapers.

In a number of instances companies have been so overwhelmed by the task of sorting and judging mail response to a newspaper job listing that they have called in ESPS in desperation to do the screening for them and to send them the few best-qualified men.

Engineer Judges Engineers

The ESPS is specially qualified to do such screening, Mr. Meyer feels, because in contrast to the average commercial agency which relies chiefly on reviewers with little knowledge of engineering work, ESPS employs only engineers who have had industrial experience. These men understand job specifications almost as well as they understand human nature as it finds expression in the engineering personality, and are able sometimes instinctively to sense

the right man for the right job. No small part of ESPS service, according to Mr. Meyer, is this bulwark against embarrassment on the part of the employer and disappointment on the part of the engineer.

Elaborating on the other advantages offered by ESPS, Mr. Meyer was careful to point out that his organization does more than fit round pegs into round holes. It has been often called upon to act as consultant on personnel difficulties of employers; often it has given advice on wage standardization, and has made surveys of men available in specific areas for particular industries.

Mr. Meyer had something to say about his observations of employment trends. Currently there is an oversupply of 1949 graduates, in fact, over 1500 of them in the New York area. It will be about four to six months before these men are placed. Recently many companies have been reducing engineering staff. The difficult problem of men in the fifties is with them again. Salaries? These are sensitive to supply and demand factors. Currently the trend seems to be downward in the face of fourth-round victories by labor, but his feeling is that salary levels are firm and any downward trend will soon be reversed.

"But the most gratifying job we have to do," Mr. Meyer went on to say, beaming with pleasure, "is the human job of giving job guidance to recent graduates and counsel to the confused and dissatisfied young engineers coming to us not so much for jobs as for a heart-to-heart talk about the cruel world which doesn't understand them."

Advice to Recent Graduates

Asked what advice he gives recent graduates, he continued, "Well, I steer them away from sales jobs because that is the beaten path that leads out of engineering. I tell them not to take a job that immediately places them on their own, because then their opportunity to learn is restricted to one particular job. What they ought to look for is a job working under an experienced engineer, whom they can watch closely and listen to, men who will show them the easy practical way of doing things. Their questions get answered quickly and they do not waste time relying on their meager resources. Many companies have excellent training courses for young engineers and we strongly recommend such employment for one getting out of school.

What about the disgruntled? "These," Mr. Meyer explained, "are the square pegs in the round holes and men who have become discouraged after four or five years in engineering. 'Disgruntled' is perhaps the wrong word for them. They do not like their boss; they are not getting paid enough; they are not learning enough, or progressing fast enough. Mostly they are good men who want an objective valuation of their personal situation from persons qualified to do so.

"We want them to come to us. The Founder Societies and the ECPD have done much to provide material which can help these men. We call this to their attention, talk to them like 'Dutch uncles,' and you'd be surprised what a difference it makes. That's why I feel ESPS is the human side of the Founder Societies."

Co-Operative Training in Great Britain

SMALL industry in Great Britain is tackling the problem of engineering apprenticeship by using a scheme in which a number of plants in one community transfer their apprentices from one plant to another to expose them to a variety of industrial experiences.

The scheme described in the August 19 issue of *Engineering*, was developed by the Enfield District Manufacturers' Association. Among the 15 firms giving the scheme a trial are a welding-equipment manufacturer, a steel mill, a cable manufacturer, and a gas public utility.

"As an example of the type of firm who could make profitable use of the scheme, a small firm engaged in manufacture and process work would need maintenance engineers on its staff; apprentices in such a department would be required to have toolroom experience, possibly specialized training on welding equipment, a wide experience of mechanical and electrical equipment, and possibly a knowledge of the operation of process and service equipment by steam, compressed air, and other fluids. Such wide training facilities might be quite outside the scope of one firm, but under the transfer scheme a knowledge of the various specialized sections could be obtained by recognized periods of training with other co-operating firms."

ESPS FILES CONTAINING PROFESSIONAL RECORDS OF 10,000 ENGINEERS REGISTERED WITH THE SERVICE

Smoke Control in New York City Wins Public Support

NEW YORKERS are being exposed to an adult course in the fundamentals of combustion designed to save them eight million dollars through more efficient handling of industrial and domestic furnaces. The instructor is William H. Byrne, member ASME, and director of the Smoke Control Bureau of the City of New York, who was appointed recently to initiate a program for smoke abatement.

Mr. Byrne's tact in laying bare the facts of the high cost of smoke, and his suggestive approach to teaching the technique for handling furnaces in winter have won him the support of the city's newspapers. The *New York Times*, particularly, is following his activities closely and after each of his public appearances is shouting "Hear! Hear!" through its editorials.

Special Program

As part of Smoke Prevention Week in New York City, Mr. Byrne organized, with the assistance of The American Society of Mechanical Engineers, National Association of Power Engineers, and the American Society of Heating and Ventilating Engineers, a two-day symposium on smoke-prevention problems. Held in the rooms of the Engineering Societies Building, the symposium was attended by local power and marine engineers, superintendents of large apartment houses, and others in charge of furnaces in the city.

In afternoon and evening sessions authorities on combustion gave practical instruction on characteristics of bituminous and anthracite coal, operation of incinerators, operation of steamship and tugboat boilers, use of instruments as a smoke-prevention measure, and smoke problems of the public utilities. An evening session in the Engineering Societies auditorium was devoted to answering questions on combustion by a panel of experts.

Realistic Appropriations Sought

By working for a realistic appropriation to pay for the smoke-abatement program, Mr. Byrne is laying a groundwork for future attacks that he feels will show results in two years and will avoid the one factor which has defeated smoke abatement in other cities even before the programs were launched.

Mr. Byrne was one of several engineers recommended to Mayor William O'Dwyer for the job of director of the city's newly authorized Smoke Control Bureau by a conference of local engineering and civic groups called together for that purpose by the Metropolitan Section of The American Society of Mechanical Engineers.

ASME NEWS

1949 Annual Meeting Program Rich in Fare for Mechanical Engineers

Headquarters: Hotel Statler, New York, N. Y.
Nov. 27– Dec. 2

THE program of the 1949 Annual Meeting of The American Society of Mechanical Engineers to be held at the Hotel Statler, New York, N. Y., Nov. 27–Dec. 2, 1949, like the program of any going professional society, is well worth study, for it tells a good many things to the practicing engineer.

This is so because an annual meeting just does not happen to happen. It is the end result of thousands of answers to the eternal question: "What Is Important?" which every agency in the ASME must answer in determining its contribution to the Annual Meeting program. To the busy engineer who wants to keep informed on the new ideas and information which point the way in mechanical engineering, the following pages describing the 74 technical sessions and more than 300 technical papers, as well as a number of social events, virtually say, "These people, these researches, these techniques, these opinions, these experiences are important."

Men With Special Knowledge

Each paper is important in the opinion of the Professional Division sponsoring it. Each author is an expert in his field. Because it may be true that what an author has to say on one subject may be only slightly more significant than what he did not say on some other subject not covered by his paper, the program can serve as the key to men working in specific fields on important matters. It opens the office doors to men who have special information to contribute.

While each member will read carefully the program of the professional divisions in which he is registered, he will be unwise if he overlooks featured events at the Annual Meeting. These are the luncheons, dinners, and special lectures. It is through these events that Society leadership points to what is important in the social and economic world in which the engineer practices his profession—the things an engineer must know if, as an educated man, he is not to be surprised at what tomorrow holds in store.

Women in Design

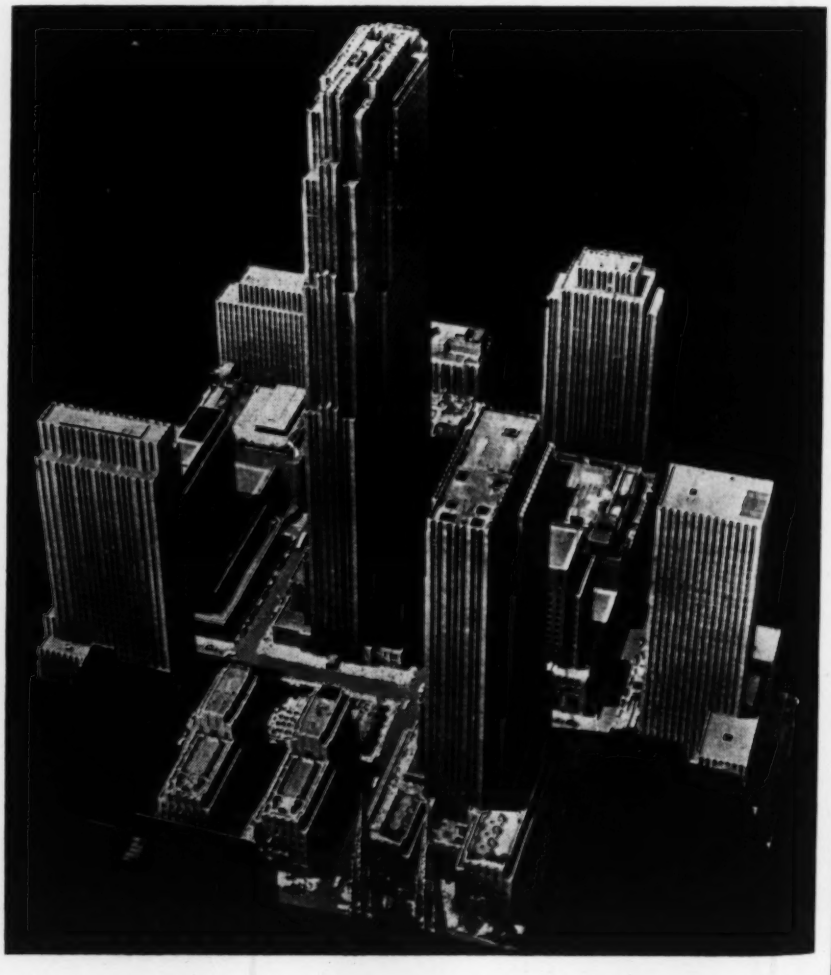
The keynote speaker at the President's luncheon, it will be noted, is Lillian M. Gilbreth who will talk on "What Is Human Engineering?" To many it will be apparent that in 1949 engineering is less a man's vocation than it was in 1899, and that like its sister professions of medicine and law, engineering is benefiting from the contributions of women.

The theme of the meeting, "The Engineers' Contribution to a Peaceful World," is not just a pleasing phrase. Studded through the program are such papers as those on wood finishes for pianos and fine furniture, isotopes as tools of engineering, new techniques in air-cargo handling, performance of the Illinois smokeless furnace in homes, potentialities of a 4000-hp gas-turbine locomotive for passenger service, and others which show that in the fifth year of the peace, more and more engineers are giving thought to strengthening the props of the American standard of living.

This year the ASME is honored to have as its banquet speaker H. J. Gough, president, The Institution of Mechanical Engineers. His talk, "May We Co-Operate?" brings to mind the increasing interest of American engineers in overseas opportunity, President Truman's "fourth point," and on the part of the ASME and the Engineers Joint Council a desire to co-operate with engineers in all democratic countries.

Wright Memorial Lecture

The first Wright Memorial Lecture to be delivered by Arthur T. Vanderbilt, Chief Justice of the Supreme Court of New Jersey, on "Standards for Citizenship," will honor the work of the late Roy V. Wright, who for many years almost singlehanded talked citizenship to engineers who preferred other subjects. This event elevates citizenship to



ROCKEFELLER CENTER, CITY WITHIN A CITY, WHICH HOUSES THE MUSEUM OF SCIENCE AND INDUSTRY

the rank it deserves in a democracy, to the "big league" among professional problems with power, mechanical design, management, and others over which engineers are happy to sweat.

Junior Session

Several other thoughts will occur to one who reads the Annual Meeting program. Junior members, for example, are sensing their responsibility for their own progress and have invited spokesmen for large and small business to inform them on what industry and government employment offers in way of opportunities for professional development.

Engineers in management, as indicated by the 1949 Annual Meeting sessions of the Management Division, are scrutinizing the management functions, and are formulating clear statements on management's obligations to create a better life, to reduce production and distribution costs, to improve quality of products, to provide industrial leadership, and finally, to be competent.

Railroad Opportunities

The railroad industry is reburnishing its slate of career opportunities in an effort to compete with the glamour technologies which are winning the best of the annual crop of graduates. It is telling its story as the largest materials-handling industry in the United States.

The American Rocket Society, completing its fifth year as an affiliate of the ASME, has earned the respect of rocket authorities and thereby the right to speak for rocket engineers. ASME has cause for pride in the high technical level of the four sessions scheduled for the Annual Meeting.

Hotel Reservations

The first week in November is late for best room reservations for the Annual Meeting. Members are urged when writing for rooms to state type of rooms desired, names of occupants, and expected times of arrival and departure. This information will avoid registration delays and will assure the best available accommodations.

College Reunions

Annual Meeting time is college reunion time for mechanical engineers. The following reunions are scheduled:

University of California: Berkeley and Los Angeles: 6:30 p.m., Dec. 1. Bonat Cafe, 330 West 31st Street. Master of ceremonies: Prof. R. G. Folsom. Address of welcome: Dean M. P. O'Brien. Speaker: Dean L. M. K. Boelter. Contact Lowell A. Ledgett, Colgate-Palmolive-Peet Company, Jersey City, N. J.

Clarkson College of Technology, 6 p.m., Dec. 1. Dinner meeting, The Building Trade Employers Association, 26th floor, 2 Park Avenue.

The Cooper Union. Mechanical-engineering laboratories open for inspection, Thursday evening, Dec. 1. Social hour, 5:30 p.m. to 6:30 p.m. in the department office, room 106-H, Hewitt Building. Informal dinner, 6:30 p.m., Nikolous Chop House, 99 Second Avenue. For further details call Prof. William Vopat as early in the week as possible at Algonquin 4-6300.

Cornell University: 6 p.m. Dec. 1, Dinner at Dogwood Room, Blackstone Hotel, 50 East 58th Street. 8 p.m. Trip to I.B.M. Headquarters, 590 Madison Avenue, to inspect the I.B.M. Selective Sequence Electronic Calculator. Cornell engineers and guests are invited.

Georgia Institute of Technology: 6:15 p.m. Dec. 1. Dinner meeting, Engineers Club, 32 West 40th Street. Reservations may be made with Dudley W. King, 63 Wall Street, New York 5, N. Y., or call Whitehall 4-2590.

Harvard University: Dec. 1. Harvard Club, 27 West 44th Street. For details see final program.

University of Illinois: 12:15 p.m., Nov. 30. Luncheon in the Panel Room, New Yorker Hotel. For details phone F. O. Gaskill, Murray Hill 7-8000.

University of Michigan: Luncheon on Thursday, Dec. 1. Inquire at registration desk for further information.

New York University: 5 p.m. to 7 p.m., Dec. 1. Social hour, Chelsea Room, Governor Clinton Hotel. Reunion arranged by Prof. A. H. Church, Ludlow 4-0700.

Northeastern University: Inquire at registration desk for further information.

Purdue University: 6:30 p.m., Nov. 29. Stouffer's Restaurant, 540 Fifth Avenue. Speaker: Dean A. A. Potter.

Rensselaer Polytechnic Institute: 12:45, Dec. 1. Luncheon, Hotel Statler. For further information call Mr. A. J. Gerdon at Murray Hill 2-2974.

Stevens Institute of Technology: Dec. 1. Open house at the Stevens Metropolitan Club, 106 West 56th Street. 5:30 p.m. cocktails. 6:30 p.m. dinner sponsored by the Stevens Metropolitan Club. 8 p.m. midwinter meeting of the Alumni Association.

University of Wisconsin: Dec. 1. Dinner at the Hotel Statler.

Worcester Polytechnic Institute: 7 p.m., Dec. 1. Dinner at the Advertising Club, 23 Park Avenue. Guests: Rear Admiral W. T. Cluverius and Mr. Donald Smith.

Women's Program

The Woman's Auxiliary of the Metropolitan Section has arranged an interesting program for wives of members and guests attending the Annual Meeting. In addition to luncheons and teas, there will be inspection trips to the British ocean liners *Brittanic* and *Mauretania*, to The Cathedral of St. John the Divine, and to the New York Stock Exchange.

Official Notice

ASME Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday afternoon, Nov. 28, 1949, at 5:00 p.m. in the Hotel Statler, New York, N. Y., as a part of the Annual Meeting of the Society.

Members are urged to attend.

The Tentative Program

MONDAY, NOVEMBER 28

Production Engineering (I)

9:30 a.m.

A Study of Cutting-Face Finishes and Treatments on Twist-Drill Performance, by C. E. Bierwirth, master mechanics division, Buick Motors Division, General Motors Corporation, Flint, Mich.

Correlation of Plastic Deformation During Metal Cutting With Tensile Properties of the Work Material, by R. C. Grassi and J. T. Lapsley, Jr., assistant professors, and Erich G. Thomson, associate professor, mechanical engineering, University of California, Berkeley, Calif.

Hydraulic (I)

9:30 a.m.

Centrifugal and Axial-Flow Compressors Hydraulic Performance, by A. J. Stepanoff, development engineer, Ingersoll-Rand Company, Phillipsburg, N. J.

The Flow Through Centrifugal Compressors and Pumps, by H. E. Sheets, Goodyear Aircraft Corporation, Akron, Ohio.

Investigations of Axial-Flow Compressors, by W. D. Rannie, assistant professor of mechanical engineering, and R. H. Sabersky, instructor in mechanical engineering, California Institute of Technology, Pasadena, Calif., and J. T. Bowen, naval ordnance test station, Inyokern, Calif.

Wright Memorial Lecture

CHIEF JUSTICE Arthur T. Vanderbilt of the Supreme Court of New Jersey, will deliver the first Wright Memorial Lecture on Tuesday, Nov. 29, 1949, at 5:15 p.m. in the grand ballroom of the Hotel Statler. His subject will be "Standards for Citizenship."

Justice Vanderbilt is one of the most respected members of the American Bar. He is a brilliant speaker and a man of indefatigable energy. Conducting one of the largest private law practices in New York City, he was able to serve as dean of the New York University Law School, lecture on law, and head a national committee which simplified criminal procedure in the Federal courts. When New Jersey adopted its new constitution he was called in to reorganize that state's court system. Justice Vanderbilt sets a fierce professional pace. His colleagues report that he regularly begins his office day at seven in the morning and works around the clock to one in the morning without showing physical strain.

The lecture honors the memory of Roy V. Wright, who as chairman of the Engineers Civic Responsibility Committee did so much to awaken engineers to the need for assuming political responsibility.

President's Luncheon

12:15 p.m.

Presiding: James M. Todd, president ASME
Speaker: Lillian M. Gilbreth, Fellow ASME, president, Gilbreth, Inc., Montclair, N. J.
Subject: What Is Human Engineering?

Metals Engineering (I)

2:30 p.m.

(To appear in final program)

Industrial Instruments and Regulators (I)

2:30 p.m.

Graphical Gear-Train Design, by Lawrence Jones, Eckert-Mauchly Computer Corporation, Philadelphia, Pa.

Some Basic Studies in Proportional Control, by C. E. Mason, technical director, The Bristol Company, Waterbury, Conn., and V. Paschkis, heat and mass-flow analyzer laboratory, Columbia University, New York, N. Y.

Education (I)

2:30 p.m.

The Share or Role of Women in Design

(Speakers to appear in final program)

Gas Turbine Power (I)—Power (I)—Aviation (I)

2:30 p.m.

Survey of Work on Escher Wyss—AK Closed-Cycle Gas Turbines 1945–1950, by Curt Keller, manager of research department, Escher Wyss Engineering Works, Zurich, Switzerland. (49—A-35)

Pyrometer for Measuring Total Temperature in Low-Density Gas Streams, by E. P. Walsh, section engineer, Westinghouse Electric Corporation, Lester Pa., and Sidney Allen, Armstrong Siddeley Motors, Coventry, England. (49—A-66)

Hydraulic (II)

2:30 p.m.

Francis and Pelton Turbines, by A. Puyo, Neyrpic, Grenoble, France.

The Response of Thermocouples to Rapid Temperature Changes, by Max W. Carbone, mechanical engineer, pile technology division, nucleonics department, Hanford Works, General Electric Company, Richland, Wash.; H. J. Kutsch, instructor, school of mechanical engineering, Purdue University, Lafayette, Ind.; and G. A. Hawkins, Westinghouse research professor of heat transfer, Purdue University, Lafayette, Ind., visiting professor, 1949–1950, division of engineering, University of California, Los Angeles, Calif.

Bridge River Turbine—62,000 Hp Vertical Impulse Under 1118-Foot Head, by W. F. Boyle and I. M. White, Pelton Water Wheel Company, San Francisco, Calif.

Hydraulic-Turbine Governor Specifications, by E. B. Strowger, hydraulic engineer, Buffalo Niagara Electric Company, Buffalo, N. Y., and C. L. Avery, engineer, Woodward Governor Company, Rockford, Illinois.

Management (I)

2:30 p.m.

The Obligations Implied by Trusteeship, by Wilfred Wottrich, vice-president, Manufacturers Trust Company, New York, N. Y.

Panel Speakers: W. H. Kushnick, management consultant, Tuckahoe, N. Y.; Ralph Presgrave, J. D. Woods and Gordon, Ltd., Toronto, Can.; E. H. MacNiece, director of quality control, Johnson and Johnson, New Brunswick, N. J.; F. B. Turck, Jr., president, Turck, Hill and Company, New York, N. Y.; H. B. Maynard, president, Methods Engineering Council, Pittsburgh, Pa.; and L. C. Morrow, editor, *Factory Management and Maintenance*, McGraw-Hill Publishing Company, Inc., New York, N. Y.

Tea Dance

Immediately following Business Meeting.

Metals Engineering (II)

8:15 p.m.

(To appear in final program)

Management (II)

8:15 p.m.

The Obligation of Management to Create a Better Industrial Life:

The Obligation of Management to Create a Better Industrial Life—Labor's View, by James B. Carey, secretary and treasurer, National CIO, Washington, D. C.

The Obligation of Management to Create a Better Industrial Life—Management's View, by Fred C. Fischer, R. H. Macy, Inc., New York, N. Y.

Industrial Instruments and Regulators (II)—Aviation (II)—American Rocket Society (I)

8:15 p.m.

Automatic Temperature Control for Electrically Heated Windshields, by H. R. Karp, electrical engineer, engineering department, Eclipse Pioneer Division, Bendix Aviation Corporation, Teterboro, N. J.

A Description of an Automatic Data-Analyzing Machine, by B. S. Benson, research engineer, Douglas Aircraft Company, Inc., Santa Monica, Calif.

TUESDAY, NOVEMBER 29

Applied Mechanics (I)

9:30 a.m.

Acceleration of the Instant Center, by W. J. Carter, department of mechanical engineering, University of Texas, Austin, Texas. (49—A-9) (Presented by title)

Longitudinal and Torsional Impact in a Uniform Bar With a Rigid Body at One End, by A. H. Burr, College of Engineering, department of machine design, Cornell University, Ithaca, N. Y. (49—A-6)

A Mechanical Analyzer for Computing Transient Stresses in Airplane Structures, by R. L. Bisplinghoff, T. H. H. Pian, department of aeronautical engineering, and L. I. Levy, senior engineers, aeroelastic and structure research, Massachusetts Institute of Technology, Cambridge, Mass. (49—A-8)

Bending Vibrations of a Pipe Line Containing Flowing Fluid, by Holt Ashley, professor, and George Haviland, department of aeronautical engineering, Massachusetts Institute of Technology, Cambridge, Mass. (49—A-22)

Gas Turbine Power (II)—Railroad (I)

9:30 a.m.

A 4000-Hp Gas-Turbine Locomotive for Passenger Service, by W. A. Brecht, manager, transportation-engineering department, Charles Kerr, Jr., consulting engineer, transportation department, Westinghouse Electric Corporation, E. Pittsburgh, Pa., and T. J. Putz, manager, gas-turbine engineering department, Westinghouse Electric Corp., Lester, Pa. (49—A-26)

Gas-Turbine Power Plants in Locomotives, by R. A. Williamson, manager, railroad rolling-stock division, and A. H. Morey, locomotive engineering division, General Electric Company, Erie, Pa. (49—A-46)

Production Engineering (II)

9:30 a.m.

The Quality Control Indicator: An Automatic Version of Statistical Control Charts That Pay Off in Reduced Rejects, by R. C. Miles, refrigerator quality control division, General Electric Company, Erie, Pa.

The Manufacture of Panels for Mounting Apparatus Used in Communications Equipment, by A. S. Muessen, engineer, Western Electric Company, Inc., Kearny, N. J.

Selection of a Manufacturing Plan, by P. H. Foley, supervisor of planning and wage rate, and equipment, General Electric Company, W. Lynn, Mass.

Heat Transfer (I)

9:30 a.m.

Heat Transfer From an Air Jet to a Plane Plate With Entrainment of Water Vapor From the Environment, by Max Jakob, professor, R. L. Rose, and M. Spielman, Illinois Institute of Technology, Chicago, Ill. (49—A-16)

Pressure Drop and Convective Heat Transfer With Surface Boiling at High Heat Flux: Data for Aniline and *n*-Butyl Alcohol, by Frank Kreith, Guggenheim fellow, aeronautical-engineering department, and Martin Summerfield, editor, aeronautics publication program, Princeton University, Princeton, N. J.

Heat Transfer and Fluid Friction During Viscous Flow Across Banks of Tubes: III A Study of Tube Spacing and Tube Size, by O. P. Bergelin, associate professor, G. A. Brown, F. W. Sullivan, research fellows in chemical engineering, department of mechanical engineering, University of Delaware, Newark, Del., and H. L. Hull, chemical engineer, E. I. du Pont de Nemours and Co., Wilmington, Del.

Management (III)

9:30 a.m.

The Obligation of Management to Control Costs

The Obligation of Industrial Engineering to Control Costs, by Bruce Wallace, vice-president and treasurer, Otis Elevator Company, New York, N. Y.

The Obligation of Management to Control Costs—The Technical How, by D. M. Voightsberger, comptroller, The S. S. White Dental Manufacturing Company, Philadelphia, Pa.

The Control of Maintenance Costs From a Practical Viewpoint, by Howard Bishop, chief industrial engineer, Youngstown Sheet and Tube Company, Youngstown, Ohio.

Rubber and Plastics (I)

9:30 a.m.

Long-Time Tension and Creep Tests of Plastics, by C. E. Staff, assistant superintendent of research and development, Bakelite Corp., Bloomfield, N. J., H. M. Quackenbos, senior chemical engineer, Bakelite Corporation, Bound Brook, N. J., and J. M. Hill, Jr., Cambridge, Mass. (49—A-61)

A Theory of the Mechanical Properties of Hot Plastics, by S. J. Loring, consulting engineer, Easton, Conn. (49—A-50)

Advances in Plastics 1948-1949, by J. E. Faloon, application engineer, plastics division, General Electric Company, Pittsfield, Mass.

Aviation (III)—Materials Handling (I)—Institute of the Aeronautical Sciences (I)—Society of Automotive Engineers (I)

9:30 a.m.

Symposium on Air Cargo Transport:

Air Cargo Today—It Is Here to Stay, by Charles Froesch, chief engineer, Eastern Airlines, Inc., New York, N. Y.

What Should Be Done to Improve Cargo Aircraft, by W. W. Davies, director of engineering, United Airlines, Inc., San Francisco, Calif.

Improvements Required in Air-Cargo Ground Handling, by R. Dixon Speas, special assistant to the president, American Airlines, Inc., LaGuardia Field, New York, N. Y.

Gas Turbine Power—Aviation—Power—American Rocket Society—Industrial Instruments and Regulators—Institute of the Aeronautical Science—Society of Automotive Engineers Luncheon

12:15 p.m.

Presiding: J. K. Salisbury, Thermal Power Systems Division, General Electric Co., Schenectady, N. Y.

Toastmaster: Alex D. Bailey, vice-president, Commonwealth Edison Co., Chicago, Illinois

Speaker: Hugh L. Dryden, director of research, The National Advisory Committee for Aeronautics, Washington, D. C.

Subject: Research Airplanes

Award: Gas Turbine Power Division Award to Donald F. Warner, design engineer, General Electric Company, Lynn, Mass.

Heat Transfer Luncheon

12:15 p.m.

Presiding: L. B. Schueler, American Gas and Electric Service Corporation, New York, N. Y.

Speaker: H. C. Hottel, professor, Massachusetts Institute of Technology, Cambridge, Mass.

Subject: Uses of Solar Radiation

Applied Mechanics Division (II)

2:30 p.m.

A Method for Determining Mode Shapes and Frequencies Above the Fundamental by Matrix Iteration, by Hubert Flomenhoft, Bureau of Aeronautics, structures branch, Navy Department, Washington, D. C. (49—A-21)

Vibration of Beams Under Concentrated Impulse Loads, by A. W. Jacobson, professor, department of mathematics, Wayne University, Detroit, Mich.

Matrix Solution for the Vibration of Nonuniform Beams, by W. T. Thomson, associate professor of mechanics, University of Wisconsin, Madison, Wis. (49—A-11)

Beam Vibrations With Time-Dependent Boundary Conditions, by R. D. Mindlin, professor, and L. E. Goodman, civil-engineering department, Columbia University, New York, N. Y. (49—A-19)

Gas Turbine Power (III)—Metals Engineering (III)—Effect of Temperature on Metals (I)

2:30 p.m.

The Outlook for Ceramics in Gas Turbines, by I. E. Campbell, assistant supervisor, and W. H. Duckworth, ceramic division, Battelle Memorial Institute, Columbus, Ohio. (49—A-57)

Metallurgy of Gas-Turbine Materials, by N. L. Mochel, manager, metallurgical engineering, Westinghouse Electric Corporation, Lester, Pa.

Education (II)

2:30 p.m.

The Continued Education of Engineers in Industry, by J. C. McKeon, manager, university relations, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Orientation and Training of the Young Engineer in Industry, by J. S. Crout, assistant to the director, Battelle Memorial Institute, Columbus, Ohio

Professional Registration of the Young Engineer, by H. L. Solberg, professor, school of mechanical engineering, Purdue University, Lafayette, Ind.

Self-Appraisal Methods for Valuable Characteristics in Engineering, by A. R. Cullimore, president, Newark College of Engineering, Newark, N. J.

Attention! Juniors

THE National Junior Committee has scheduled a symposium on what 1950 holds for the junior engineer in the way of professional opportunities. M. M. Boring, General Electric Company, Schenectady, N. Y., will tell what the large corporation offers a young engineer. Crosby Field, president, Flakice Corporation, Brooklyn, N. Y., who believes strongly that many young engineers are stepping over opportunity when they rush to large-corporation jobs, will speak on the young engineer's future in the small company. Finally, the general employment picture will be discussed by R. R. Behlow who, as regional director of the Bureau of Labor Statistics in New York, N. Y., knows the field well.

Date: Tuesday, Nov. 29, 8:15 p.m.

Power (II)—Fuels (I)—Materials Handling (II)

2:30 p.m.

Philadelphia Electric Company Adopts Mobile Coal-Handling Equipment, by Everett C. Russell, supervisor, coal bureau and steam heating division, Philadelphia Electric Company, Philadelphia, Pa. (49—A-63)

Storing and Reclaiming Coal With Earth-Moving Equipment at the Oswego Steam Station, by J. Norton Ewart, Buffalo Niagara Electric Corporation, Buffalo, N. Y.

Heat Transfer (II)

2:30 p.m.

Heat-Transfer to a Fluid Flowing Turbulently Between Parallel Walls With Asymetric Wall Temperatures, by R. A. Seban, College of Engineering, University of California Berkeley, Calif. (49—A-18)

Heat-Transfer Rates in Centrifugal Compressors and the Effect of Internal Liquid Cooling on Performance, by P. R. Trumpler, Illinois Institute of Technology, Chicago, Ill., W. E. Trumpler, chief engineer, centrifugal department, and R. W. Frederick, engineer, Clark Brothers Company, Inc., Olean, N. Y.

Management (IV)—Production Engineering (III)

2:30 p.m.

The Obligation of Management to Create Quality:

Psychology and Quality Control Packs a Punch, by C. R. Scott, Jr., manager, SKF Industries, Inc., Philadelphia, Pa.

The Economics of Quality Control From a Management Point of View, by Harrison Dunning, general manager, Scott Paper Company, Chester, Pa.

Hydraulic (III)

2:30 p.m.

Resistance to Rotation of Disks in Liquids, by A. H. Church and S. A. Gertz, mechanical-engineering department, New York University, New York, N. Y.

Cavitation Research With Vibratory Apparatus, by W. J. Rheingans, assistant manager, hydraulic department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Head and Flow Observations on High-Efficiency Free Impellers, by W. C. Osborne and D. A. Morelli, California Institute of Technology, Pasadena, Calif.

Rubber and Plastics (II)

2:30 p.m.

Stress Relaxation of Rubber and Rubberlike Vulcanizates Under Compression, by A. E. June, director, compounding research, B. F. Goodrich Research Center, Brecksville, Ohio

A paper by E. F. Riesing, Firestone Industrial Products Company, Noblesville, Ind.

Advances in Rubber 1948–1949, by Lois Brock, technical librarian, G. H. Swart, director of research, and E. V. Osberg, sales executive, The General Tire and Rubber Company, Akron, Ohio

Roy V. Wright Memorial Lecture

5:15 p.m.

Presiding: James M. Todd, president ASME
Speaker: Justice Arthur T. Vanderbilt, Supreme Court of the State of New Jersey
Subject: Standards for Citizenship

Hydraulic Old-Timers' Dinner

6 p.m.

Toastmaster: Carroll F. Merriam, consulting engineer, Pennsylvania Water and Power Co., Baltimore, Md.

Applied Mechanics Dinner

6 p.m.

Speaker: H. J. Gough, president, The Institution of Mechanical Engineers, London, England.
Subject: Steels Under Combined Cyclic and Static Flexural and Torsional Stresses.

Aviation (IV)—Materials Handling (III)—Institute of Aeronautical Sciences (II)—Society of Automotive Engineers (II)

8:15 p.m.

Symposium: Air Cargo Transport:

Experience and Future Requirements of Military Air Cargo, by William H. Tunner, major general, Army Air Force, deputy commander for operations, military air transportation service, Andrews Air Force Base, Washington, D. C.

Planning the Air-Cargo Terminal, by L. R. Hackney, air-cargo specialist, Lockheed Aircraft Corporation, Burbank, Calif.

National Junior Committee

8:15 p.m.

Symposium: Junior Engineer—1950:

What the Large Corporation Offers the Junior Engineer, by M. M. Boring, Manager, technical personnel division, General Electric Company, Schenectady, N. Y.

A Professional Compass for Young Engineers, by Crosby Field, president, Flakice Corporation, Brooklyn, N. Y.

Employment Outlook for Engineers, by R. R. Behlow, regional director, bureau of labor statistics, Department of Labor, New York, N. Y.

Heat Transfer (III)—Gas Turbine Power (IV)

8:15 p.m.

Design of Regenerators for Gas-Turbine Service, by D. Aronson, section engineer, Elliott Company, Jeannette, Pa.

Notes on Heat-Recovery Equipment for Gas Turbines, by D. M. Shoenfeld, manager, development department, Combustion Engineering-Superheater Inc., New York, N. Y.

Gas-Turbine Regenerators: Some Economic and Design Considerations, by H. S. Bimpson, chemical engineer, and R. A. Wilson, engineer, blower and condenser department, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Vessels Under External Pressure—Pressure-Vessel Research Committee

8:15 p.m.

Allowable Eccentricity of Spherical Heads Convex to Pressure, by R. G. Sturm, professor of engineering mechanics and research professor of materials, L. W. Smith, project engineer, Purdue University, West Lafayette, Ind., and H. L. O'Brien, research engineer, Graver Tank and Manufacturing Company, East Chicago, Ind. (49—A-70)

Mechanical Testing, Experimental Stress Analysis and Apparatus in Pressure-Vessel Research, by F. G. Tatnall, manager of testing research, Baldwin Locomotive Works, Philadelphia, Pa. (49—A-68)

Effect of Welding on Pressure-Vessel Steels, by A. F. Scotchbrook, research assistant, L. Eriv, research assistant, Fritz Engineering Laboratory, R. D. Stout, associate professor of metallurgy, and B. G. Johnston, director, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa. (49—A-49)

WEDNESDAY, NOVEMBER 30

Heat Transfer (IV)—Gas Turbine Power (V)

9:30 a.m.

Heat-Transfer and Flow-Friction Characteristics of Some Compact Heat-Exchanger Surfaces: (1) Test System and Procedure: (2) Design Data for 13 Surfaces, by W. N. Kays, acting instructor of mechanical engineering, and A. L. London, professor of mechanical engineering, Stanford University, Palo Alto, Calif.

Heat-Exchange Equipment for a 5000-Kw Gas-Turbine Generator, by George R. Fusner, gas-turbine engineering division, General Electric Company, Schenectady, N. Y. (49—A-84)

Power (III)

9:30 a.m.

The Evaluation of Steam Power-Plant Losses by Means of the Entropy-Balance Diagram, by Allen Keller, assistant division engineer, General Electric Company, Lynn, Mass. (49—A-65)

Mechanical Design and Testing of Long Steam-Turbine Blading, by H. M. Owens and W. E. Trumpler, Jr., design engineers, Westinghouse Electric Corporation, Philadelphia, Pa. (49—A-64)

Management (V)—Materials Handling (IV)

9:30 a.m.

The Obligation of Management to Lower Distribution Costs:

Distribution in Today's Business, by Chester H. Lang, vice-president in charge sales, apparatus department, General Electric Company, New York, N. Y.

Market Studies a Must in Distributing Products, by W. J. Sampson, president, American Welding and Manufacturing Company, Warren, Ohio.

A Modern Warehouse, by C. J. Whipple, chairman of the board, Hibbard, Spencer, Bartlett and Company, Evanston, Ill.

Applied Mechanics (III)

9:30 a.m.

The Calendering of Plastics Materials, by R. E. Gaskell, associate professor of mathematics, Iowa State College, Ames, Iowa. (49—A-34)

A Quantitative Comparison of Flow and Deformation Theories of Plasticity, by P. G. Hodge, Jr., and G. N. White, applied-mathematics department, Brown University, Providence, R. I. (49—A-5)

Elastic-Plastic Analysis of Structures Subjected to Loads Varying Arbitrarily Between Prescribed Limits, by P. S. Symonds and W. Prager, professors, Brown University, Providence, R. I. (49—A-13)

The Flow and Fracture of a Brittle Material, by Louis F. Coffin, research associate, General Electric Company, Schenectady, N. Y.

Fuels (II)—Power (IV)

9:30 a.m.

Symposium: Fly-Ash Utilization:

The Present and Future Magnitude of the Pulverized-Coal Fly-Ash Disposal Problems, by Henry S. Walker, director of research, The Detroit Edison Company, Detroit, Mich. (49—A-79)

Use of Fly Ash in Concrete, by Walter Handy, sales manager, Combustion By-Products Company, Chicago, Ill. (49—A-81)

Some New Developments in the Use of Fly Ash, by M. C. Randall, Sr., engineer, Philadelphia Electric Company, Philadelphia, Pa. (49—A-83)

Use of Fly Ash in the Bitumastic Road Industry, by C. N. Weinheimer, The Detroit Edison Company, Detroit, Michigan. (49—A-82)

Oil and Gas Power

9:30 a.m.

Reduction in Noise of Engines, by W. P. Green, professor, Illinois Institute of Technology, Chicago, Ill. (49—A-27)

The Relationship of Cylinder Size to Design and Performance of Internal-Combustion Engines, by C. F. Taylor, professor, Massachusetts Institute of Technology, Cambridge, Mass.

Railroad (II)—Materials Handling (V)

9:30 a.m.

Symposium: American Railroads—Our Largest Materials-Handling Industry:

Railway Rolling Stock—A Vital Problem in Materials Handling, by A. E. Perlman, general manager, Denver and Rio Grande Western Railroad Company, Denver, Colorado.

Handling Supplies Used in Railroad Operation, by Carleton W. Meyer, assistant to the president, Chesapeake & Ohio Railway Company, Cleveland, Ohio.

Machine Design (I)

9:30 a.m.

Selection of Antifriction Bearings for Machine Tools, by J. H. Baninger, assistant

chief engineer, new departure division, General Motors Corporation, Bristol, Conn. (49—A-51)

Ball and Roller-Bearing Identification Standards and Design Selection, by Aaron Hochman, cataloging officer, Department of Navy, New York, N. Y. (49—A-44)

Housings and Spindles for Antifriction Bearings, by H. L. Blood, engineer, The Heald Machine Company, Worcester, Mass. (49—A-56)

Management Luncheon

12:15 p.m.

Presiding: J. Keith Louden, vice-president and assistant to the president, York Corporation, York, Pa.

Harold B. Maynard, president, Methods Engineering Council, Pittsburgh, Pa.

Speaker: Frederick S. Blackall, Jr., president and treasurer, Taft-Peirce Manufacturing Company, Woonsocket, R. I.

Subject: The Obligation of Management to Provide Leadership

Presentation of the Gantt Medal for 1949 to Arthur Clinton Spurr, president, Monongahela Power Company, Fairmont, W. Va.

Fuels Luncheon

12:15 p.m.

Presiding: D. S. Frank, Pure Oil Company, Toledo, Ohio.

Speaker: Richard Harkness, Washington correspondent, National Broadcasting Company, Washington, D. C.

Subject: Behind the Scenes in Washington

Heat Transfer (V)—Gas Turbine Power (VI)

2:30 p.m.

A Perforated-Plate Heat Exchanger, by R. J. Bowen, H. O. McMahon, research physicist, and G. A. Bleyle, Arthur D. Little Inc., Cambridge, Mass.

The Modine Gas-to-Gas Heat Exchanger as Applied to the Elliott Oxygen Plant, by Clyde Simpelaar, chief research engineer, Modine Manufacturing Company, Racine, Wis., and D. Aronson, section engineer, Elliott Company, Jeannette, Pa.

Power (V)

2:30 p.m.

Some Factors Influencing the Economics of Reheat Installation, by H. A. Wagner and R. W. Hartwell, engineering department, The Detroit Edison Company, Detroit, Mich.

Selection of Steam Conditions for No. 4 Unit—Riverside Generating Station, by R. C. Dannettel and G. S. Harris, Consolidated Gas Electric Light and Power Company of Baltimore, Baltimore, Md. (49—A-62)

A Comparison of Costs of Reheat Versus Non-Reheat for 100-Mw Units, by R. P. Moore, mechanical engineer, Buffalo-Niagara Electric Corporation, Buffalo, N. Y.

Railroad (III)—Materials Handling (VI)

2:30 p.m.

Symposium: American Railroad—Our Largest Materials-Handling Industry:

Modern Freight-House Design and Operation. (To be announced)

Materials-Handling Devices Used in Maintaining Railroad Rolling Stock, by S. H. Hammond, president, The Whiting Corporation, Harvey, Ill.

Fuels (III)

2:30 p.m.

Laboratory and Home Performance of the Illinois Smokeless Furnace, by J. R. Fellows, University of Illinois, Urbana, Ill., and J. W. Norris, Lennox Furnace Company, Marshalltown, Iowa. (49—A-28)

Effect of Pressure on the Combustion of Pulverized Coal, by T. T. Omori, California Institute of Technology, Pasadena, Calif., and A. A. Orning, coal research laboratory, Carnegie Institute of Technology, Pittsburgh, Pa. (49—A-72)

Continuous Gasification of Pulverized Coal With Oxygen and Steam by the Vortex Principle; A Progress Report, by H. Perry, chemical engineer, research and development branch, Office of Synthetic Liquid Fuels; R. C. Corey, supervisor, combustion research section, coal branch, Bureau of Mines, Pittsburgh, Pa., and M. A. Elliott, assistant chief, research and development branch, Office of Synthetic Liquid Fuels, Bureau of Mines, Bruceton, Pa. (49—A-73)

Machine Design (II)—Petroleum (I)

2:30 p.m.

Maintenance of Antifriction Bearings, by J. M. Bruening, president, The Ohio Ball Bearing Company, Cleveland, Ohio. (49—A-54)

Characteristics of Greases as Related to Antifriction-Bearing Applications, by E. S. Carmichael and R. C. Robinson, engineers, technical service department, Socony-Vacuum Oil Company, New York, N. Y. (49—A-52)

Oil Lubrication of Ball and Roller Bearings, and J. P. Critchlow, lubrication engineer, Gulf Oil Corporation, Pittsburgh, Pa.

Fluid Meters

2:30 p.m.

Influence of Compressibility on Cylindrical Pitot-Tube Measurements, by L. W. Thrasher and R. C. Binder, professor, school of mechanical engineering, Purdue University, Lafayette, Ind. (49—A-31)

Determination of ASME Nozzle Coefficients for Variable Nozzle External Dimensions, by R. C. Folsom, professor, department of mechanical engineering, University of California, Berkeley, Calif.

Calibrations of Six Beth-Flow Meters at Alden Hydraulic Laboratory, Worcester Polytechnic Institute, by L. J. Hooper, professor of hydraulic engineering, Alden Hydraulic Laboratory, Worcester Polytechnic Institute, Worcester, Mass. (49—A-38)

Management (VI)—Education (III)

2:30 p.m.

The Obligation of Management to Be Competent

The Obligation of Management to Be Competent, by Thomas H. Nelson, partner, Rogers and Slade, New York, N. Y.

Development of Executives, by George B. Corless, director of executive development, Standard Oil Company of New Jersey, New York, N. Y.

Are Untrained Supervisors on Your Payroll Making Things Go Wrong? by Gordon Van Ark, manager, personnel development division, General Foods Inc., New York, N. Y.

Applied Mechanics (IV)—Hydraulic (IV)

2:30 p.m.

An Approximate Solution for Incompressible Flow About an Ellipsoid Near a Plane Wall, by Phillip Eisenberg, Navy Department, David Taylor Model Basin, Washington, D. C. (No. 49—A-7)

Stability of Flow in a Rocket Motor, by Dwight F. Gunder, professor, department of mechanics of engineering, Cornell University, Ithaca, N. Y., and D. R. Friant, M. W. Kellogg Company, Jersey City, N. J. (49—A-15)

Some Experiments on the Interaction of Shock Waves With Boundary Layers on a Flat Plate, by Frank W. Barry, A. H. Shapiro, and E. P. Neumann, professors, Massachusetts Institute of Technology, Cambridge, Mass. (49—A-3)

An Investigation of Ejector Design by Analysis and Experiment, by J. H. Keenan, E. P. Neumann, professors, and F. Lustwerk, Massachusetts Institute of Technology, Cambridge, Mass. (49—A-25)

Annual Dinner and Honors Night

6 p.m.

Subject: May We Co-Operate?

Speakers: H. J. Gough, president, The Institution of Mechanical Engineers, London, England.

James M. Todd, president ASME, will also speak.

THURSDAY, DECEMBER 1

High-Temperature Steam Generation—Effect of Temperature on Metals (II)—Heat Transfer (VI)—Power (VI)

9:30 a.m.

Heat Transfer to Superheated Steam at High Pressures, by W. H. McAdams, professor of chemical engineering, Massachusetts Institute of Technology, Cambridge, Mass., W. E. Kennel, research department, Standard Oil Company of Indiana, Whiting, Ind., and James N. Addoms, assistant professor of chemical engineering, Massachusetts Institute of Technology, Cambridge, Mass. (49—A-32)

Possibilities of the Regenerative Steam Cycle at Temperatures up to 1600 F, by P. H. Knowlton, assistant to the manager of engineering, turbine division, General Electric Company, Schenectady, N. Y., and R. W. Hartwell, engineer, mechanical-engineering division, engineering department, The Detroit Edison Company, Detroit, Mich. (49—A-33)

Applied Mechanics (V)

9:30 a.m.

Thermoelastic Stress Around a Cylindrical Inclusion of Elliptic Cross Section, by R.

D. Mindlin, professor, Columbia University, New York, N. Y., and Mrs. H. L. Cooper, Bell Telephone Laboratories, New York, N. Y. (49—A-20)

Torsion of Noncylindrical Shafts of Circular Cross Section, by H. J. Reissner, professor, Polytechnic Institute of Brooklyn, Brooklyn, N. Y., and G. J. Wennagel, Grumman Aviation Engineering Corporation, Bethpage, Long Island, N. Y. (49—A-12)

Stresses and Deflections of Cylindrical Bodies in Contact With Application to Contact of Gears and of Locomotive Wheels, by H. Poritsky, consulting engineer, General Electric Company, Schenectady, N. Y. (49—A-14)

Petroleum (II)

9:30 a.m.

Turbine-Oil Maintenance and Purification Problems, by H. J. Klotz, Stone and Webster Engineering Corporation, Boston, Mass.

Diesel-Oil Maintenance and Purification Problems, by T. M. Robie, director of quality control, Fairbanks Morse Company, Beloit, Wis.

Safety—Machine Design (III)

9:30 a.m.

The Theory and Application of Machine Guarding, by R. J. Crosby, manager of safety engineering, Marsh and McLennon, Inc., New York, N. Y. (49—A-45)

Isotopes as Tools of Engineering, by Paul C. Aebersold, chief, isotopes division, Oak Ridge Operations, United States Atomic Energy Commission, Oak Ridge, Tenn. (49—A-59)

Safe Handling of Radioisotopes, by George G. Manov, chief, and D. O. Lintz, health physicist, advisory field service branch, isotopes division, United States Atomic Energy Commission, Oak Ridge, Tenn. (49—A-58)

Process Industries (I)

9:30 a.m.

Cyclone Dust-Collector Design, by Melvin W. First, research fellow, Harvard School of Public Health, Boston, Mass.

The Reduction of the Pressure Drop Across Vortex Dust Collectors, by F. B. Schneider, designing engineer, locomotive engineering division, General Electric Company, Erie, Pa.

Railroad (IV)—Management (VII)

9:30 a.m.

Symposium: Attracting Mechanical-Engineering Graduates to the Railroad Industry:

Discussions by:

F. K. Mitchell, manager of equipment, New York Central System, New York, N. Y.

J. B. Akers, chief engineer, Southern Railway System, Washington, D. C.

L. W. Wallace, counselor on management, Cincinnati, Ohio

American Rocket Society (II)

9:30 a.m.

Fundamental Problems in Rocket Research, by M. J. Summerfield, executive editor, rocket research series, Project SQUID, Princeton University, Princeton, N. J.

The Strategic Materials in Jet and Rocket Engines, by Col. M. C. Demler, United States Air Force, Washington, D. C.

Wood Industries (I)

9:30 a.m.

Late Developments in Finishing Materials for Wood Products, by M. A. Kindig, manager, eastern industrial division, Sherwin-Williams Company, Newark, N. J.

Wood Finishing by Spray Process, by L. W. Lamminan, The DeVilbiss Company, Toledo, Ohio. This paper to be presented by H. Niedhammer, same company, located in New York, N. Y. (49—A-67)

Finishing Piano Cases in Production, by Carl Lusch, chief production engineer, Lester Piano Manufacturing Company, Inc., Lester, Pa. (49—A-77)

Finishing Fine Furniture and Reproductions, by Ralph Keller, general manager, W. and J. Sloan Company, Ridgefield, N. J.

Materials Handling (VII)

9:30 a.m.

The Solution of a Materials-Handling Problem in a Metalworking Plant, by C. H. Delamater, works manager, Aluminum Company of America, Bridgeport, Conn.

Materials-Handling Economies in Pulp and Paper Mills, by R. S. Mackenzie, assistant to president, Union Bag and Paper Corporation, New York, N. Y.

Members and Students Luncheon

12:15 p.m.

Machine Design Luncheon

12:15 p.m.

Presiding: T. F. Githens, mechanical engineer in charge of engineering, The Cleveland Twist Drill Company, Cleveland, Ohio

Speaker: Tell Berna, general manager, National Machine Tool Builders' Association, Cleveland, Ohio

Subject: Developments in the Machine-Tool Industry

Materials Handling Luncheon

12:15 p.m.

Presiding: H. C. Keller

Speaker: R. C. Sollenberger, executive secretary, Conveyor Equipment Manufacturers' Association, Washington, D. C.

Subject: Conveyer Installations

Wood Industries Luncheon

12:15 p.m.

Furnace Performance Factors—Fuels (IV)—Power (VII)—Heat Transfer (VII)

2:30 p.m.

Furnace Heat Absorption in Pulverized-Coal-Fired Steam Generator, Using Turbulent Burners at Paddy's Run Station, Louisville, Ky.

Part I Variation in Heat Absorption as Shown by Measurement of Surface Temperature of Exposed Side of Furnace Tubes, by R. I. Wheater and M. H. Howard, manager, service department, Foster-Wheeler Corporation, New York, N. Y., A. G. Rosenbaum, general superintendent, and F. B. Tetzel, superintendent, steam-power production, Louisville Gas and Electric Company, Louisville, Ky.

Part II Furnace Heat Absorption Efficiency as Shown by the Temperature and Composition of Gases Leaving the Furnace, by R. C. Corey, supervising engineer, and Paul Cohen, fuel engineer, combustion-research section, Bureau of Mines, U. S. Department of the Interior, Pittsburgh, Pa. (49—A-42)

Part III Comparison and Correlation of the Results of Furnace Heat Absorption Investigation, by H. H. Hemenway, executive assistant, and R. I. Wheater, service department, Foster-Wheeler Corporation, New York, N. Y.

Petroleum (III)

2:30 a.m.

Hydraulic Oil Maintenance and Purification Problems, by Joseph Ragee, general supervisor of lubrication, and James R. Sloan, staff metallurgist, Caterpillar Tractor Company, Peoria, Ill.

Maintenance of Roll-Neck Bearing Lubricants, by J. T. Bunting and R. O. Lovendahl, Aluminum Company of America, Pittsburgh, Pa.

Process Industries (II)—Petroleum (IV)

2:30 p.m.

A Modern Development in Absorption Refrigeration Using Water Vapor, by A. A. Berestneff, project supervisor, Carrier Corporation, Syracuse, N. Y.

Oil-Refinery Waste Treatment, by E. M. Proctor, Proctor, Redfern and Laughlin, Toronto, Ontario, Can. (49—A-78)

Machine Design (IV)

2:30 p.m.

Design Considerations for Manufacturing Economy, by R. W. Bolz, associate editor, *Machine Design*, Cleveland, Ohio. (49—A-53)

The Use of Special Machinery to Increase Production and Improve Quality at Reduced Cost, by C. A. Nichols, master mechanic, Delco-Remy division, General Motors Corporation, Anderson, Ind.

Railroad (V)

2:30 p.m.

Progress in Railway Mechanical Engineering—1948–1949 Report of Committee RR-6-Survey, by T. F. Perkinson, manager, transportation engineering division, General Electric Company, Schenectady, N. Y.

Address by O. V. S. Bulleid, chief mechanical engineer, Southern Region—British Railways, London, England.

The Talgo Train—The New Lightweight Articulated Train Built by American Car and Foundry Company, by J. M. Gruitch, director, research and development, American Car and Foundry Company, New York, N. Y.

Materials Handling (VIII)

2:30 p.m.

Engineering the Belt-Conveyer Installation, by H. Von Thaden, executive vice-president, Hewitt-Robins Inc., New York, N. Y.

The Profits of Mechanized Handling, by R. C. Sollenberger, executive secretary, Conveyor Equipment Manufacturers' Association, Washington, D. C.

American Rocket Society (III)

2:30 a.m.

Program of Instruction and Research at the Daniel and Florence Guggenheim Jet-Propulsion Center, by H. S. Tsein, director, Guggenheim Center of Jet Propulsion, California Institute of Technology, Pasadena, Calif.

Research in Jet Propulsion at the Guggenheim Center of Jet Propulsion, Princeton University, by J. V. Charyk, department of aeronautical engineering, Princeton University, Princeton, N. J.

Performance Parameters for Several Applications of Rocket Power Plants, by G. P. Sutton, supervisor, propulsion development aerophysics laboratory, North American Aviation, Inc., Downey, Calif.

Wood Industries (II)

2:30 p.m.

Improved Nails, by George Stern, research professor, Virginia Polytechnic Institute, Blacksburg, Va.

Cutting Action of Shaper Knives, by L. A. Patronsky, assistant professor of wood technology, University of Michigan, Ann Arbor, Mich.

Recent Developments in Cutters for the Wood Industry, by W. Burdette Wilkins, consulting engineer, Ridgewood, N. J.

New Developments in Hose for Forest Service Use, by J. M. Flounders, manager, hose sales, B. F. Goodrich Company, Akron, Ohio, and R. B. Sargent, general manager, Hale Fire Pump Company, Conshohocken, Pa.

Applied Mechanics (VI)

2:30 p.m.

Gaskets and Bolted Joints, by Irving Roberts, process division, research and development department, Elliott Company, Jeannette, Pa. (49—A-2)

Crushing Strength of Aluminum Tubes, by E. Creutz, professor, Carnegie Institute of Technology, Pittsburgh, Pa. (49—A-23)

Bending of an Elliptical Plate by Edge Loading, by W. A. Nash, assistant professor, department of engineering mechanics, University of Notre Dame, South Bend, Ind. (49—A-4)

Approximate Solutions of Problems of Plane Plastic Flow, by P. G. Hodge, Jr., professor applied mathematics, Brown University, Providence, R. I. (49—A-10) Presented by E. H. Lee, professor, Brown University, Providence, R. I.

American Rocket Society Dinner

6 p.m.

Presiding: G. Edward Pendray, president, Pendray and Leibert, Inc., New York, N. Y.
Speaker: Dan A. Kimball, Under Secretary of Navy, Washington, D. C.
Subject: The Complexities of Peace

Power (VIII)—Society of Naval Architects and Marine Engineers

8:15 p.m.

Marine Night

Vibration of Marine Turbine Blading, by Robert W. Nolan, Newport News Shipbuilding and Dry Dock Company, Newport News, Va. (49—A-76)

The Design of a Class of 28,000-Ton Tankers, by H. deLuce and W. I. H. Budd, Bethlehem Steel Company, Quincy, Mass.

Lubrication (I)—Petroleum (V)

8:15 p.m.

A Mathematical Evaluation of Pressures in a Grease-Lubricated Bearing, by K. B. Lawrence, instructor, department of mechanical engineering, The Pennsylvania State College, State College, Pa. (49—A-69)

Investigation of Lubricants for Power Circuit Breakers, by R. R. Bush, development engineer, General Electric Company, Philadelphia, Pa. (49—A-17)

Properties of Gases—Heat Transfer (VIII)—Applied Mechanics (VII)

8:15 p.m.

Zero-Pressure Thermodynamic Properties of Some Monatomic Gases, by J. A. Goff, dean, Towne Scientific School, and director of thermodynamics research laboratory; Serge Gratch, assistant professor of mechanical engineering, Towne Scientific School, and project leader, thermodynamics research laboratory, University of Pennsylvania, Philadelphia, Pa., and S. W. Van Voorhis, Upper Montclair, N. J.

Zero-Pressure Thermodynamic Properties of Carbon Monoxide and Nitrogen, by J. A. Goff, dean, Towne Scientific School, and director of thermodynamics research laboratory, and Serge Gratch, assistant professor of mechanical engineering, Towne Scientific School, and project leader, thermodynamics research laboratory, University of Pennsylvania, Philadelphia, Pa. (49—A-50)

The Thermodynamic Properties of Helium, by S. W. Akin, general engineering and consulting laboratory, General Electric Company, Schenectady, N. Y.

Some New Values of the Second Enthalpy Coefficient for Dry Air, by J. R. Andersen, assistant professor, Towne Scientific School, University of Pennsylvania, Philadelphia, Pa.

Thermodynamic Properties of Mercury Vapor, by L. A. Sheldon, General Electric Company, Schenectady, N. Y.

New Measurements of the Heat Conductivity of Steam and Nitrogen, by F. G. Keyes, professor of physical chemistry, and Dewey J. Sandell, graduate student, Massachusetts Institute of Technology, Cambridge, Mass. (49—A-43)

Compilation of Thermal Properties of Wind-Tunnel and Jet-Engine Gases at the National Bureau of Standards, by H. J. Hoge, thermodynamic section, National Bureau of Standards, U. S. Department of Commerce, Washington, D. C.

The Compressibility Factor of Hydrogen at High Pressures, by H. L. Johnston, professor, department of chemistry, The Ohio State University, Columbus, Ohio.

Machine Design (V)

8:15 a.m.

Recognition of the Engineer, by G. M. Muschamp, vice-president in charge of engineering, Brown Instrument Company, Division of Minneapolis-Honeywell Regulator Company, Philadelphia, Pa. (49—A-47)

The Influence of Shape of Cross Section on the Flexural Fatigue Strength of Steel, by T. J. Dolan, J. H. McClow, and W. J. Craig, engineering experiment station, University of Illinois, Urbana, Ill. (49—A-55)

FRIDAY, DECEMBER 2

Boiler Feedwater Studies (I)—Power (IX)

9:30 a.m.

Hide-Out of Sodium Phosphate in High-Pressure Boilers, by F. G. Straub, research professor in chemical engineering, University of Illinois, Urbana, Ill. (49—A-39)

Chemical Treatment, Demineralization or Evaporation for Make-Up in High-Pressure By-Product Steam Plants, by J. D. Yoder, vice-president, The Permutit Company, New York, N. Y.; W. L. Webb and T. Baumeister, mechanical-engineering division, American Gas and Elecric Service Corporation, New York, N. Y. (49—A-71)

Lubrication (II)—Petroleum (VI)

9:30 a.m.

The Hydrodynamic Lubrication of Cyclically Loaded Bearings, by E. M. Simons, Battelle Memorial Institute, Columbus, Ohio. (49—A-41)

The Mechanism of Lubrication Failure in High-Speed Ball Bearings, by F. C. Jones and D. F. Wilcock, engineer, bearing and lubricants center, General Electric Company, West Lynn, Mass. (49—A-36)

Turbulence in High-Speed Journal Bearings, by D. F. Wilcock, engineer, bearing and lubricants center, General Electric Company, West Lynn, Mass. (49—A-37)

Textile (I)

9:30 a.m.

Changing the Attitude of Careless Workers, by A. G. Klock, quality-control superintendent, Bigelow-Sanford Carpet Company, Inc., Thompsonville, Conn.

Sewing Threads, by Stefan L. Grapnel, research engineer, Belding Heminway Corticelli, Putnam, Conn.

The Modern Concept of Air Conditioning, by Phillip Langford Davidson, consulting engineer, Philadelphia, Pa.

American Rocket Society (IV)—Fuels (V)

9:30 a.m.

Hydrogen Peroxide as a Propellant, by Noah S. Davis, Jr., manager, Ralph Bloom, Jr., and Samuel D. Levine, project supervisors, special projects department, Buffalo Electro-Chemical Company, Buffalo, N. Y.

Nitrogen Textroxide as an Oxidizer in Rocket Propulsion, by Douglas H. Ross, assistant manager, products development department,

The Solvay Process Division, Allied Chemical and Dye Corporation, New York, N. Y.

The Handling of Liquid Oxygen, by G. E. Simpson, division superintendent of distribution, Linde Air Products, Inc., New York, N. Y.

Boiler Feedwater Studies (II)—Power (X)

2:30 p.m.

Sulphite and Silica in Boiler Water at Springdale Station, by L. E. Hankison, superintendent of efficiency, and M. D. Baker, chief chemist, West Penn Power Company, Springdale, Pa. (49—A-75)

An Automatic Degasser for Steam Sampling in Power Plants, by H. M. Rivers, W. H. Trautman, research department, Hall Laboratories, Inc., Pittsburgh, Pa., and G. W. Gibble, Arabian-American Oil Company, Ras Tanura, Saudi Arabia. (49—A-74)

Lubrication (III)—Petroleum (VII)

2:30 p.m.

A Simple Hydrodynamic Thrust Bearing, by F. R. Archibald, assistant professor of mechanical engineering, school of engineering, Princeton University, Princeton, N. J. (49—A-29)

Density-Pressure Relationships for Two Low-Viscosity Dimethyl Siloxanes, by S. B. Gunst, Gulf Research and Development Company, and University of Pittsburgh, Pa.

Textile (II)

2:30 p.m.

More Than 600 Attend ASME Fall Meeting at Erie, Pa.

Engineers' Civic Responsibility Is Theme

A HARD-WORKING and enthusiastic committee of Erie Section members provided an excellent and varied technical and social program for the more than 600 ASME members and guests who attended the 1949 Fall Meeting of The American Society of Mechanical Engineers, held in the Hotel Lawrence, Erie, Pa., September 27–30, 1949. Numerous inspection trips included in the rigorous schedule pointed up the diversified industry centered around Erie. Throughout the meeting the responsibility of the engineer in civic affairs was stressed.

Papers in the fields of gas turbines, railroads, aviation, machine design, oil firing, pressure vessels, heat transfer, instrument engineering, coal handling and cleaning, metals engineering, rubber and plastics, education, materials handling, and management were presented at the well-attended technical sessions. Thumbnail sketches of papers appear in following pages.

Gas Turbines

A gas turbine for automobiles was described, which offers a simple device consisting of a prime mover and torque converter in a single unit. Only two rotating elements and a single speed reducer are required (49—F-12).[1] Also, the results of a preliminary investigation of a small-output, about 10-hp, gas-turbine development were given (49—F-1). A gas-turbine cycle was discussed in which the combustion chamber is placed behind the turbine, raising the exhaust temperature to a level at which all the heat required for the compressed air can be supplied by the heat exchanger (49—F-6). Typical chemical and physical properties of the various types of fuel oils for industrial gas-turbine usage, which should prove useful to design engineers, were also given (49—F-8).

A progress report on the General Electric Company's gas-turbine-electric locomotive indicates no serious trouble. Roadability, handling, etc., were said to be excellent. Most difficulties encountered were considered of the "nuisance" variety, and not directly attributable to the gas-turbine plant itself.

Another paper revealed that research and development programs are now under way to bring about a coal-fired locomotive to equal or better the operating cost, performance, and availability of the present Diesel locomotive. This program is very evident because of the possible future scarcity of oil. Two basic locomotives are being considered—the gas turbine and the steam turbine, both combined with an electric drive (49—F-15).

A method for calculating the tractive force of reciprocating steam locomotives was outlined. It results in a system whereby the power at any speed can be calculated by first determining the theoretical mean effective pressure at this speed from the engine dimensions and a steam supply, either calculated or assumed, and then in turn multiplying the theoretical mean effective pressure by the diagram factor corresponding to the speed considered and the cylinder displacement to steam capacity ratio of the locomotive (49—F-5).

The many devices used in testing the various materials, parts, appurtenances, and methods used in the manufacture of locomotive cars in Class A-1 Railroads were described. Undercar engine-driven power plants for railroad passenger cars were discussed. The history of development, the basic design factors, and the units of the system were outlined (49—F-7, published in full on pages 921–924 of this issue).

Vibration Problems

To combat vibration in aircraft, the basic characteristics, simplified design data, and limitations were presented on the use of elastomeric materials suitable for structural parts, thus allowing the aircraft designer to make adequate provisions for such parts (49—F-9). A practical approach to the problem of vibration and shock isolation in aircraft also was given. The contribution of engine, propeller, and transient excitations as sources of mechanical and aerodynamic disturbances were discussed with emphasis on information obtained from instrumental flight and ground tests.

A case was presented wherein a recurring transient condition endangered a turbine disk previously judged safe under steady-state conditions. It was shown that the varying temperature distribution which exists in the turbine disk during warm-up and take-off can sufficiently lower the critical speed so that during this transient interval the disk operates at its critical for a short period of time (49—F-18). Another paper dealt with the performance of a device for picking up stationary gliders by means of a tow plane in flight. It outlined a theoretical analysis of a pickup operation, the results of laboratory tests conducted by the U. S. Army Air Force, and a comparison of theoretical and field pickup results (49—F-10).

T. KEITH GLENNAN (*left*), PRINCIPAL SPEAKER AT FRIDAY'S LUNCHEON, ENJOYS CHAT WITH M. M. BORING

Special Boring Machine

The development of a special four-spindle boring machine for finishing traction-motor magnet frames was outlined. Factors taken into consideration in its development are the accuracy and alignment of bores and the squareness of faces; flexibility for use on a range of model sizes; adaptability of carboloy tooling; special fixturing; provision for automatic cycling; and design for lower unit cost (49—F-3). A brief history of heavy-duty bearings with intermittent oscillatory motion was reviewed and the requirements for modern circuit breakers were discussed (49—F-2; published in full on pages 911–916 of this issue).

The importance of associating failures and changes in properties with metals used in high-temperature service—up to 1000 F—was emphasized. It was pointed out that changes in metal structure with time at high temperature can and do occur. The use of specially designed alloys to prevent these metallurgical changes is shown to be the sensible approach to such problems (49—F-14). The details of the gearing, operating, and control mechanism of

[1] Numbers in parentheses refer to preprint numbers assigned to the papers. Digests of Fall Meeting preprinted papers Nos. 49—F-3 49—F-4, 49—F-14, and 49—F-15, were published in the ASME Technical Digest section of the October, 1949, issue of MECHANICAL ENGINEERING. For digests of remaining preprinted papers referred to in this account of the meeting, see pages 943–950 of this issue.

a surgical operating table were described and illustrated. Special consideration was given to the selection of materials, method of lubrication, and finishes (49—F-4).

Installation design, operating practices, and fuel-oil factors pertaining to industrial oil firing, were covered (49—F-17); and a brief review of the design of the setting and furnace for small oil-fired burners was given (49—F-16).

Pressure Vessels

Concerning pressure vessels, an analysis of data obtained by steam-gage experimental stress analysis on drum heads and nozzle openings in drum shells was presented (49—F-19). The factors which the fabrication of pressure vessels must consider in carrying out a design were discussed, and the types and handling characteristics of materials were described. In another paper, the phase of development in pressure-vessel testing techniques during the last 10 years, was discussed (49—F-20).

At a heat-transfer session a method was proposed whereby the temperature pattern around a single buried heat source at a given temperature is used to arrive at the pattern obtained, when several heat sources at the same temperature are placed at any distance apart (49—F-13). Temperature charts in dimensionless units were presented, for heating a semi-infinite slab by internal heat sources (49—F-26). Graphs were given which can be used to determine the economic thickness of the insulation used on cylinders, such as pipe coverings (49—F-27).

The growth of instrument engineering was discussed, with emphasis on improved control, control practices, the dynamics problem measurements without shutdown, and future problems (49—F-11).

The important design features, equipment, and requirements of coal-handling systems for central power plants were described. (See page 935 of this issue for further details).

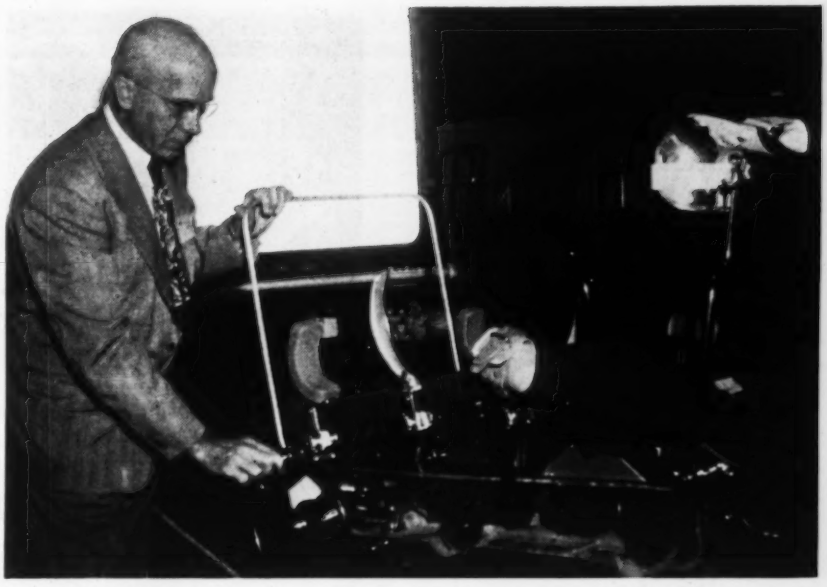
A paper describing the application of the "Electro-Cycle" system of spindle control to small-size turret lathes for purposes of reducing machine-handling time in a total job cycle, was presented (49—F-25).

Fly-Ash Symposium

In a symposium on fly-ash erosion, papers were presented which discussed the following: The primary factors contributing to the rate of fly-ash erosion in boilers (49—F-24); the experiences of one boiler-manufacturing company with fly-ash erosion in various boiler units (49—F-21); the conditions which result in fly-ash erosion with typical examples of preventing erosion (49—F-23); and fly-ash erosion difficulties encountered on units burning particularly abrasive material (49—F-22).

Metals-engineering papers covered heavy forgings, the use of supersonic instruments for testing heavy forgings, and testing and inspection of open-die forgings.

In the field of rubber and plastics, the physical properties of polymethyl methacrylate were described; the effects of cyclic and of continuous immersion in heptane, toluene, and 5R-6, a test fuel, on the weight, dimensions, and flexural properties of 19 samples of laminated plastics, were determined; and the results of mechanical tests on the following laminated plastics were reported: canvas laminate molded at low pressure, grade-C laminate, rayon laminate, and polyester glass-fabric laminate.



R. L. JEWELL DEMONSTRATES SURGICAL OPERATING TABLE WHICH HE DESCRIBED AT ONE OF THE TECHNICAL SESSIONS

The latest designs of heavy machinery for processing rubber and plastics were reviewed. It was pointed out that the speeds, production, and power requirements are being increased, and greater attention is being given to reduction of wear and maintenance. The development of machinery for the curing of tires was also outlined. A paper dealing with the reasons for considering time as a variable as well as temperature, pressure, rate of flow, and liquid level, particularly in the rubber and plastics field, was presented.

The many types of materials-handling equipment required to handle scrap efficiently were described; another paper covered the broad range of materials-handling problems encountered by one company in the handling of very light materials to very dense and bulky materials, and from bulk to highly concentrated loads.

In a two-paper symposium on "Management—A Trusteeship," one paper discussed employee and community relations (see pages 925–928 of this issue for complete paper). The other paper pointed out that management's responsibility is to safeguard the security of private capital, reward it with adequate wage, and do its share to create a proper atmosphere for the successful operation of the business.

Erie Extends Warm Welcome

The 185 ASME members and guests who were fortunate enough to obtain tickets for the opening day's luncheon on Wednesday were greeted with a heartfelt welcome by J. C. Rhoads, Mem. ASME, General Electric Company, Erie, Pa., who was toastmaster; M. V. Kitzmiller, chairman, Erie Engineering Council; and the Honorable Joseph C. Martin, the mayor of Erie. All three extended the warmest of greetings and expressed best wishes for a most successful meeting. Mr. Rhoads then introduced James M. Todd, president ASME, who acknowledged the Erie welcome and hoped that Erie's industries—both labor and management—would derive some benefit from the technical program which was prepared for this meeting. President Todd then read a telegram from Clarence E. Davies, Secretary ASME, who congratulated the Erie Section on its excellent program and wished them success in this 1949 Fall Meeting.

The principal speaker at this luncheon, Mortimer B. Graham, secretary, Hammermill Paper Company, Erie, Pa., explained how Erie made use of engineering knowledge to produce its mass products. He discussed the phases of engineering in Erie history, past and present. For instance, he pointed out that during the last century Erie was a great iron-working center and specialized in that field. But today, he said, Erie has many diversified industries. Some of the products being manufactured in and around Erie were listed by Mr. Graham. He mentioned the electric locomotive, the first American gas-turbine locomotive, refrigerators, conduits, fine paper, boilers, engines, machine tools, plastics, magnetic separators, radio parts, steam hammers, slide fasteners, all types of forgings, hospital equipment, and many others.

Engineers and Civic Contributions

With civic responsibility as the theme, the luncheon on Thursday was enthusiastically received by the 175 ASME members and guests who attended. The principal speaker, K. B. McEachron, Jr., Mem. ASME, General Electric Company, Schenectady, N. Y., addressed the guests on "Civic Responsibility Is Everybody's Business Now." F. A. Faville, Mem. ASME, president, Faville-Le Vally Corporation, Chicago, Ill., introduced the speaker with a few brief remarks on the engineer's civic responsibility. Mr. McEachron then

pointed out how, in many communities, engineers as a group have made significant contributions to the solution of such problems as traffic planning, stream pollution, or school construction. In our preoccupation with such local and immediate problems, he said, we have often failed to sense the increasing scope of social and economic legislation. We seldom consider them to be a definite part of our civic responsibilities.

To meet these civic responsibilities, Mr. McEachron suggested that as citizens and ASME members we should do the following:

First, we must stop thinking of this problem in terms of political parties and election returns. Only as each one of us becomes an effective salesman for economic democracy will we turn the tide of misunderstanding and ignorance which threatens to sweep over us.

Second, we must take every opportunity to correct unsound ideas in all our personal contacts, whether with taxi driver, barber, grocer, or banker.

Third, we can pool our efforts to provide better economic education for ourselves and those entering the profession than we have yet had. Such a project might well extend through all the Sections and student branches of the ASME and combine the best efforts of those in education and management.

What road America will travel rests with its citizens—you and me, he stated in conclusion. Only as we as individuals challenge economic fallacies wherever we find them, and work to develop throughout the engineering profession a new understanding of economic problems, will we help to decide what road that shall be.

E. Y. Knobloch, president of the Union Iron Works, and Erie Chamber of Commerce, Erie, Pa., served as toastmaster.

The Engineer-Citizen

The banquet on Thursday evening was of course the outstanding social function during the Meeting. In an inspiring message to ASME members, President Todd kept the civic-responsibilities ball rolling by urging engineers to present views on questions of vital public interest. He pointed out that the entire economic picture of the United States, and of the world, presents a challenge to ours, the engineering profession—a challenge which it accepts. We are definitely charged with the responsibility of carrying the American way of life—the democratic processes—to new peoples, to new nations, as well as preserving our own privileges. He declared that we must be strong to shake off the centralized controls which stifle initiative and put security ahead of venture.

PRINCIPALS AT THE BANQUET ON THURSDAY

(*Left to right:* Senator Edward Martin of Pennsylvania, James M. Todd, president ASME, and C. R. Barber, State Treasurer of Pennsylvania.)

Our nation has accepted the responsibility for aiding those nations who wish to help themselves. As individual engineers, and through organized bodies of engineers such as ASME, the profession is aiding the work to accomplish that end. Through Engineers Joint Council, of which ASME is a member, the engineering profession is doing its best to support the work of ECA.

In the final analysis, however, President Todd emphasized, the discharge of individual responsibility as a citizen, as an engineer, will be of greatest importance in keeping this nation and the world on the road to continued peace.

The principal speaker at the banquet, Senator Edward Martin, Republican, of Pennsylvania, declared that local self-government, and with it the freedom of the individual in the United States, is being trampled by the increasing number of Americans who by-pass their boroughs and city halls, county courthouses, and state capitols in their rush to Washington for aid. He warned the banquet audience to "always remember that final control is held by the level of government which furnishes the money." There are three steps in the process, he said: first, advice, then supervision, and finally complete control.

In a special long-distance amplified telephone hookup, which came as a surprise to the guests at the dinner, James D. Cunningham, ASME president-elect, who was attending a meeting in White Sulphur Springs, Va., called President Todd to "acknowledge and accept this great honor."

C. R. Barber, state treasurer of Pennsylvania, was the toastmaster.

The Fallacy of Security

At Friday's luncheon, T. Keith Glennan, president of Case Institute of Technology, Cleveland, Ohio, told the ASME members and guests that today's younger generation is responsible for a "rotton spot" in our social and economic thinking as a nation—overemphasis of security. He said evidence of this trend toward overemphasis of security comes from many sources including personnel officers of large corporations who find in their recruiting of college graduates that it is far too frequently the deciding factor in the choice of employment. The trend, he declared, is deplorable but understandable.

The young men and women who are being graduated now have lived their impressionable years in a period of depression, extreme governmental paternalism, devastating war, and now an uncertain peace, said Dr. Glennan. Small wonder that it has become more the rule than the exception for the present graduate to seek security.

Dr. Glennan said that institutions of higher learning could use the help of industry in correcting this attitude on security as a service to the individual student and the nation.

Declaring that the engineering school and industry have long co-operated with each other to their mutual benefit, Dr. Glennan said this partnership must now be expanded. Engineering colleges, especially the privately

J. C. RHOADS (*left*), F. D. MOSHER (*center*), AND G. W. WILSON GET TOGETHER DURING BANQUET

endowed schools, must now broaden the scope of their co-operation with industry, in order to merit probable control.

But, he declared, our role must not be that of mendicants in cap and gown seeking industrial alms. In this partnership, he said, technological education must contribute its fair share—if possible more than its fair share.

Dr. Glennan said engineering education could expand its co-operation with industry by increasing its efforts to give industry the type of personnel it wants and needs, taking a continuing interest in the graduate after he has left the campus, and giving industry well-trained recruits in the current struggle against foreign ideologies.

M. M. Boring, Mem. ASME, General Electric Company, Schenectady, N. Y., acted as toastmaster.

Inspection Trips

On Tuesday, September 27, the plant of the Alco Products Division of the American Locomotive Company at Dunkirk, N. Y., was visited by ASME members and guests. The group toured through the heat-transfer fabricating and assembly shops, pressure-vessel shop, pipe-fabrication shop, and laboratories. This plant manufactures a large variety of heat-transfer and process equipment for oil refineries, chemical plants, and power plants.

The two plants of Talon, Inc., world's oldest and largest manufacturer of zippers, located in Meadville and Erie, Pa., were visited in another tour by members and guests, also on Tuesday. The visitors were welcomed at the Meadville plant, and tours were planned through the two Meadville manufacturing units to show how the famous Talon zippers are made.

Electric Refrigeration

The Erie Works of the General Electric Company, which produces electric refrigerators and home freezers, and electric-traction equipment, was visited on Wednesday. The tour through the Household Refrigerator Division gave the visitors opportunity to see the manufacture of refrigerating units, household refrigerator cabinets, and home freezers. In the Locomotive and Car Equipment Divisions they visited the Railway Control and Railway Motor Manufacturing Divisions. Both of these divisions produce electric-traction equipment for application by both GE and other builders of transportation vehicles. The tour also included the Locomotive Manufacturing Division where the visitors viewed the construction of Diesel-electric and electric locomotives for industrial, mine, and railroad service.

The American Sterilizer Company, leading manufacturers of hospital equipment for over 50 years, extended a welcome to ASME Meeting visitors on Thursday.

Modern Forge Shop Seen

The Erie Forge Company and its subsidiary, the Erie Forge and Steel Company, Erie, Pa., was host to ASME visitors on Friday. The group saw turbine rotor and generator shafts; ship shafts, such as line and propeller; bending roll forgings; turbine shafts for hydro-electric installations, etc., in the process of manufacture. A modern forge shop, the latest in heat-treating equipment, and a host of specially built finishing machines were also viewed with considerable interest by the guests.

Women's Program

An interesting program was planned by the Erie Section for the women who attended this year's Fall Meeting. This included luncheons, afternoon tea, plant trips, sight-seeing, and a show at the Playhouse.

On Wednesday a group visited the General Electric Community Center for luncheon, where they heard Miss Lucy Norton, of GE's personnel department, give an interesting and humorous talk on personnel problems. After luncheon the women made an extensive tour of the GE Refrigerator Division where they saw the refrigerators and home freezers which play such important parts in their everyday lives, in the process of manufacture.

In the late afternoon the women enjoyed tea at the Behrend Center, a branch of Pennsylvania State College, after which they toured its beautiful grounds.

Evening at the Theater

The evening was spent at the Playhouse where the ladies, as well as the men, were treated to a highly commendable performance of "Command Decision," the recent Broadway stage hit. It was produced by the Erie Civic Theater Association.

Sight-seeing in and around Erie was conducted on Thursday morning, followed by luncheon at the Kahkwa Country Club. After luncheon there were Bingo games.

On Friday morning the ladies were conducted through the Talon zipper plant which the men had visited on Tuesday.

Committees

The following committees of the Erie Section were responsible for the success of the meeting: *General*, G. W. Wilson, general chairman, F. D. Mosher, vice-chairman; *Technical Events*, B. S. Cain, chairman, F. D. Gowans, vice-chairman, R. W. Bronson, H. C. Curtiss, H. C. Goetz, W. C. Harris, G. H. Kaemmerling, F. M. Kirkpatrick, F. C. Kreitler, Jr., H. G. Mueller, A. J. Showler; *Entertainment*, J. L. Knight, chairman, R. W. Bronson; *Inspection Trips*, R. W. Bronson, chairman; *Information and Registration*, W. W. Peters, chairman; *Finance*, W. L. Hunter, chairman; *Reception*, G. L. Lindsay, chairman; *Hotel*, Dudley Selden, chairman; *Publicity*, H. W. Gouldthorpe, chairman; *Ladies*, Mrs. Dudley Selden, chairman.

Do You Want These ASME Publications?

THE following publications of The American Society of Mechanical Engineers are available to any interested person, library, or school merely for the packing and transportation charges: ASME Transactions, 1906–1926, inclusive (bound); ASME Transactions, 1935–1947, inclusive; Journal of the ASME, 1914–1918; MECHANICAL ENGINEERING, 1919 to present; and Record and Index for 1927, 1928, and 1929. The Journals and MECHANICAL ENGINEERING are not bound and the advertising section has been removed from most of the issues. All this material is in excellent condition and should prove to be of value to any engineering library, personal or otherwise.

All inquiries are to be directed to Mrs. Walter W. Hagerty, 2121 W. Market Street, Pottsville, Pa., through whose generosity this gift is made possible.

Regional Delegates Review New Publications Plan

THE review of the publications plan of The American Society of Mechanical Engineers, instituted in January, 1948, to save costs, was one of the main items of business of the Regional Delegates Conference, held June 26, 1949, during the ASME Semi-Annual Meeting, San Francisco, Calif.

Following prolonged discussion of various aspects of the new plan, which placed Transactions and *Journal of Applied Mechanics* on a subscription basis and introduced other changes, delegates representing each of the eight Regions of the Society unanimously adopted the following resolution:

Sound in Principle

"It is the opinion of the 1949 Regional Delegates Conference that the present publications plan is sound in principle, although it is apparent that some of the details of the distribution of papers and publications require further study. The conference commends the Publications Committee for their work to date and urges continued effort on their part to resolve the problems of distribution in accordance with the wishes of the membership as expressed in motions previously passed by this Conference and consistent with good economy and member relations. It is urged that the Publications Committee publish in the current year a review of the present publications plan outlining the general policies, costs, problems, and other pertinent information which will adequately inform the membership."

A report of the first year's experience with the plan is currently being prepared by the Publications Committee. This should be made public at the Annual Meeting.

ASME General Session

The Regional Delegates Conference is the "general assembly" of the ASME. It meets once a year, usually during the Semi-Annual Meeting. Composed of two delegates from each of the Regions, the conference takes under surveillance all aspects of Society activity. While its functions are purely advisory, its recommendations to Council have an important influence on Society policy.

Wood Industries Division Holds Successful Annual Meeting

WITH the furniture manufacturing and woodworking industries in and around Jamestown, N. Y., serving as an appropriate environment, the ASME Wood Industries Division held its annual conference in the Hotel Jamestown, Sept. 27, 1949.

The program included technical topics on adhesion, resinous wood adhesives, glue spreaders, high-frequency gluing, cutterheads for wood, and postwar wood finishes, and numerous inspection trips and enjoyable social events.

In the morning session, which was devoted to gluing and adhesives, G. M. Kline, Mem. ASME, and F. W. Reinhart of the National Bureau of Standards, discussed the chemical and physical phenomena involved in adhesion and cohesions. Four general types were described: electrostatic, covalent, and metallic, which are referred to as primary-valence bonds, and residual bonding attraction forces, known as secondary-valence bonds. A digest of this paper, 49—WDI-5, appears on page 950 of this issue.

Resinous Adhesives

Some recent developments in resinous wood, adhesives were outlined by Henry Grinsfelder of the Rohm and Haas Company, Inc., in the second paper. He pointed out that both powdered and liquid forms of the urea-formaldehyde class are receiving attention, and that primary recent interest in phenolic developments has been directed toward obtaining fast-curing phenolics for the hardwood industry. He also reported that wood adhesives based on polyvinyl-acetate emulsions were more fully developed during 1946 and 1947. (A digest of this paper, 49—WDI-4, appears on page 950 of this issue.)

Glue Spreaders

Thomas D. Perry, Mem. ASME, in his paper on glue spreaders, stated that the equipment to spread the right amount of adhesive is of definite importance, particularly in such a highly competitive product as plywood. His study is directed toward the shape and size of grooves in the spreader rolls, which transfer the ridges of liquid glue to the wood. (A digest of Mr. Perry's paper, 49—WDI-1, appeared on page 857 of MECHANICAL ENGINEERING, October, 1949.)

In the final paper of the morning session, W. H. Hickok, of the Girdler Corporation, spoke on high-frequency gluing as applied to assembly work.

Cutterhead Selection

In the evening sessions a paper on cutterhead selection and application, presented by Kenneth W. Duff, of Henry Disston and Sons, Inc., indicated that the degree of finish required has considerable bearing upon the selection of the cutterhead used. The finer the finish the more accurate must be the selection. With proper cutterhead and knives, he said, it is possible to produce work that is comparable with sanded finishes in many cases. Mr. Duff pointed out that defects in planing can be eliminated largely by use of the proper cutterhead. (This paper is published in full on pages 899–905 of this issue of MECHANICAL ENGINEERING.)

Wood Finishing

A paper on postwar wood finishing, presented in two sections, ended the meeting. Part I, given by Paul S. Kennedy of the Interchemical Corporation, was based on current practice, and discussed synthetic fillers, lacquers, and synthetic coatings such as the alkyd-urea-base compositions. Part II, presented by W. T. Smith, also of Interchemical Corporation, discussed a suggested method for predicting check resistance of lacquers. (A digest of this paper, 49—WDI-2, appeared on page 858 of MECHANICAL ENGINEERING, October, 1949.)

Local Industries Visited

Four nearby manufacturers played host to ASME members and guests during this meeting. Approximately forty of the guests inspected the Crawford Furniture Manufacturing Corporation and the Jamestown-Sterling Corporation, both in Jamestown, and the Kling Factories in Mayville, N. Y., where they saw the manufacture of bedroom furniture primarily from maple and cherry wood. In all three plants the guests were conducted through the lumber storage yards, dry kilns, and into the workshops where parts for the furniture were being mass-produced with modern woodworking machinery. They viewed conveyerized assembly lines at the end of which the piece was complete, even to the surface finish.

At Jamestown Veneer and Panel Company, in Jamestown, fifteen members and guests saw the manufacturing processes involved in making flat plywood panels. Operations included ripping, edge gluing, high-frequency gluing, bonding, and the like.

Annual Luncheon

At the luncheon, G. E. Helgram, treasurer, Kling Factories, Mayville, N. Y., as presiding officer, welcomed the conference to Jamestown.

Earl O. Hultquist, president, Jamestown Royal Upholstery Corporation, Jamestown, N. Y., was the principal speaker. He chose as his subject "Engineering and Statesmanship," in which he declared that engineers have done more in the past 25 years to advance industry than any other group. He said there are still many people, however, who look to politicians for an easier way of life instead of to the engineer and scientist. The United States has a practical monopoly on technical people, he said, and these engineers and scientists should be consulted more than in the past.

Buyer's Catalog Guide

In this issue beginning on page 39 through to page 66 of the advertising section, are listed 256 items about our advertisers' latest available catalogs, bulletins, and literature covering engineering equipment, materials, and services. Use the coupon on page 40 to make a selection.

ASME Calendar

of Coming Events

Nov. 27–Dec. 2
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(*Final date for submitting papers was Aug. 1, 1949*)

April 12–14, 1950
ASME Spring Meeting, Hotel Statler, Washington, D. C.
(*Final date for submitting papers—Dec. 1, 1949*)

April 24–26
ASME Process Industries Division Conference, William Penn Hotel, Pittsburgh, Pa.
(*Final date for submitting papers—Dec. 1, 1949*)

June 12–16
ASME Oil and Gas Power Division Conference, Lord Baltimore Hotel, Baltimore, Md.
(*Final date for submitting papers—Feb. 1, 1950*)

June 12–16
ASME Fourth National Materials Handling Exposition and Conference, International Amphitheater, Chicago, Ill.
(*Final date for submitting papers—Feb. 1, 1950*)

June 19–23
ASME Semi-Annual Meeting, Hotel Statler, St. Louis, Mo.
(*Final date for submitting papers—Feb. 1, 1950*)

June 22–24
ASME Applied Mechanics Division Conference, Purdue University, Lafayette, Ind.
(*Final date for submitting papers—Feb. 1, 1950*)

Sept. 11–15
ASME Instruments and Regulators Division Conference, Municipal Auditorium, Buffalo, N. Y.
(*Final date for submitting papers—May 1, 1950*)

Sept. 25–27
Petroleum Mechanical Engineering Conference, Hotel Roosevelt, New Orleans, La.
(*Final date for submitting papers—May 1, 1950*)

(*For Meetings of Other Societies see page 957*)

ASME Junior Forum

COMPILED AND EDITED BY A COMMITTEE OF JUNIOR MEMBERS, ROBERT L. REICH, CHAIRMAN

Survey Shows Juniors Are Active in Section Activities

IF IT is true in engineering, as it appears to be in the pure sciences, that new ideas show preference for the young in heart, The American Society of Mechanical Engineers may expect soon to be effervescing with "bold and imaginative" ideas on many fronts.

This happy thought is inspired by two things: one, the large number of student members transferring to the junior grade, which is making the average ASME member younger as the Society grows older; and two, a survey conducted by the National Junior Committee last June which shows that junior members are not being denied responsibility in the local sections, but are, in fact, claiming a sizable lump of the ASME leadership for their own.

A questionnaire was sent to all ASME sections primarily to learn who were the outstanding junior members in each section, and incidentally to accumulate a few facts on such questions as: (1) How many juniors were serving on executive, programs, professional divisions, and other committees? (2) Were juniors attending section meetings? and (3) What was the general state of junior programs across the country?

In spite of unfavorable weather which usually prevails during June and July, 53 of the 73 Sections returned the questionnaire, in most cases with comment. The results tabulated on a per-section basis are shown in Table 1.

The National Junior Committee was particularly gratified by the tone of the comments. There is apparently no junior problem with regard to junior and senior member relationship within the Society.

Twenty-nine Sections reported that junior members were so well integrated in administrative responsibility that no junior group was necessary. Some said that the Section was too small to support such a separate junior program, but mostly the comments stressed that juniors are represented on the executive and program committees and had their say on what the Section was planning to do. Only seven sections reported having separate junior groups, three of these operating satisfactorily, and four disintegrating for unexplained reasons.

The comments are amply substantiated by the answers received to other questions. In Region V with 11 Sections reporting, the average number of juniors on the executive committee was four, with two members on the program committee to look after junior preferences in the way of program fare. The Sections in this region named an average of six junior members each, as outstanding in Section activities.

When asked for a rough appraisal of results of junior activities, only two Sections reported "unsatisfactory"; 28 said "satisfactory," and 14 "highly satisfactory."

In spite of all the facts which show that junior members have good representation on Section program-making agencies, and that the junior ranks abound with leaders, the attendance of juniors at Section meetings is disappointing. In Region I only 22 per cent of the junior members come out to section meetings. In Region V where junior leadership is especially active, the percentage is only 38. How much importance is to be placed on the rough estimates submitted on this point is questionable. It does suggest, however, that some juniors who complain about what the Society does for them probably are not making the best of their opportunities, or do not fully appreciate the National Junior Committee's slogan, "It's Up to You."

TABLE 1 ASME JUNIOR ACTIVITY REPORT, JUNE, 1949

Regions	Sections in Region	Sections reporting	Averages per Section: Committees Exec.	Committees Program	Committees Prof. Div.	Committees Others	Outstanding Juniors	Attend. %	Appraisal of results H	S	U
I	10	5	3	1.8	–	3.4	3.4	22	1	3	–
II	1	1	(Junior activities undergoing reorganization)					–	–	–	1
III	12	9	2.2	1.4	0.2	5	4.4	30	3	3	–
IV	11	10	2.1	2.5	–	5.6	4.3	34	3	6	–
V	13	11	4	2	1.4	15.1	6	38	1	6	1
VI	13	7	2.6	2.1	0.28	4.3	4	34	3	4	–
VII	7	5	1.4	2.2	1.8	13.4	5	51	2	3	–
VIII	6	5	1.3	0.62	–	1.1	3.1	36	1	3	1
Totals	73	53							14	28	3

H highly satisfactory
S satisfactory
U unsatisfactory

A Measure of Security

IN recent times we as a people are putting much emphasis on security. The amount of money which we invest in insurance becomes tremendous. Our government by popular demand has established social-security plans as well as employment insurance and even savings-bank insurance. These are all important and deserve our best attention but I fear that there are other types of insurance to which we pay too little attention. Consider the following hypothetical, and as you know, not too unusual case.

"I was a good student and when I finished college I was given a good position with the XYZ company. As I was a diligent worker I rose to a good position as a designer of steam locomotive boilers. Our methods of design were empirical and although several more analytical methods were suggested their basis for development was complicated and what rough experimental data we were able to obtain agreed satisfactorily with our formulas for the particular units with which we worked. My wife and I are quiet folks and we own a small place out of town which we have fixed up attractively. We have two children, ages 9 and 15. Last spring my company closed its design work on locomotive boilers and I was let out. Since then I've been having a tough time finding someone who can use my experience. They all say I'm too old to break into a new line and that my practical experience and empirical background on fire-tube boilers is not too useful on the boilers now used. It's terribly discouraging to have all the money which I've been saving for my kids' education and my retirement disappearing because I can't find a job."

It seems to me that we should all prepare ourselves for such an eventuality as this. It is perfectly proper for us to learn the special aspects of one particular business while working but at the same time we should realize that a real engineer must continue his learning process after he has left college. He should keep his calculus brushed up and should keep in touch with the broad sidelines of his particular specialty. Above all he should contribute and be active in always trying to improve the particular work in which he specializes. In this way he will come to be known and respected by other men than those with whom he works and will have the breadth which is required for a position which is in an allied field but not identical to that in which he has gained his experience. As an assistance in carrying forward such work, membership in the ASME is an insurance well worth

its cost if we take advantage of what it offers.

The men who furled the sails on the clipper ships used to say "One hand for Jack and one hand for the ship." It is fine to give eight hours per day of good honest work to our employer, or maybe nine or ten, but it is also well to spend a little time in keeping the cobwebs out of the corners of our engineering knowledge and in keeping friendly with men working in similar fields.—F. E. R.

Junior Committee Takes Up Forum Policy

THE first meeting of the National Junior Committee in the 1949–1950 season was held in the Engineering Societies Building, New York, N. Y., Oct. 1, 1949. Those present were: Donald E. Jahncke, chairman, J. B. Burkhardt, F. Everett Reed, and G. B. Thom, members; B. H. Edelstein, Joseph A. Falcon, advisory members; R. L. Reich, editor, ASME Forum, and A. F. Bochenek, ASME staff.

The morning and afternoon sessions were given over to a free-for-all discussion on policy for the ASME Junior Forum. The idea was expressed that the Forum should reflect the activities of the National Junior Committee, and that these activities should be predicated on two things: An understanding of the forces active in the engineering profession today, and a body of beliefs or opinions about those forces.

It was maintained that the Forum should comment on such trends in engineering as: the unification of the profession, engineering registration, and the programs of the Engineers' Council for Professional Development, which aims to encourage postgraduate training for engineers. Around each of these important activities the National Junior Committee should build up a body of opinion, pro and con, so that junior members in the Society may be able to make up their own minds, and participate in them as informed members of the profession.

Junior advisers on ASME national administrative committees were invited to attend the National Junior Committee meeting. It is hoped that more of the advisers will be present at future meetings. These men can keep the Committee informed on what is going on in the Society, and can contribute statements on some of the questions now up before the engineering profession.

The Committee also gave its final approval to a draft of a brochure prepared by the Committee for distribution among student members. The brochure is intended to tell students of the advantages of ASME membership and how the Society serves as a steppingstone to responsibility in engineering.

Who's Who in the National Junior Committee

MEMBERS of the National Junior Committee are free targets for all questions and comment on junior activities in The American Society of Mechanical Engineers. The following biographical sketches of some of the Committee members were written to inform junior members about the men who are representing them in the councils of the Society with the hope that such information would encourage an informal exchange of ideas.

Donald E. Jahncke

Donald E. Jahncke who has served as chairman of the National Junior Committee since its inception in 1947, is a graduate of Tulane University, New Orleans, La. He took his master's degree at the Harvard Business School in 1941 and was licensed in Michigan as a professional engineer in 1947. His first job in industry was in the Plymouth Division of the Chrysler Corporation where he worked in various capacities, including a special assignment under the vice-president in charge of manufacturing. He is currently with the Lincoln-Mercury Division of the Ford Motor Company as assistant manager of the financial-analysis department. When it comes to Fords, Lincolns, and Mercurys, he has all the answers. The shadow of a suggestion is enough to set him off on a financial analysis of the wonderful products of Ford.

That Mr. Jahncke enters wholeheartedly into activities of his professional societies is evident by the long list of offices he has held since 1937 when he took over the job of chairman of the Tulane ASME student branch.

Like many other engineers he likes to sit back while record symphonies resound to the rafters of his home at Grosse Point, Mich. His hobbies are children (which is promising), dogs, power boating, and reading.

At 32 he has been married five years and has two children.

John B. Burkhardt

John B. Burkhardt joined the Committee in 1948 after attending many meetings in an advisory capacity. He is a graduate of Purdue University. In 1941 he went with the Commonwealth Edison Company of Chicago and has been there ever since. After completing the company orientation course for graduate engineers, he was placed in the office of the superintendent of generating stations.

For the past four years he has been teaching steam power in the company's evening program.

Mr. Burkhardt has served as chairman of the Chicago Section Junior Group and for two years was a member of the Executive Committee of the Chicago Section. At National Junior Committee meetings, Mr. Burkhardt speaks up for junior members in the Midwest. He is married and has two children.

F. Everett Reed

F. Everett Reed who comes from Boston to attend National Junior Committee meetings, speaks for the juniors in Region I. Born near Stonington, Conn. the home town of many a clipper-ship skipper, where he attended a one-room white schoolhouse, it was only chance and circumstance that he is not now a salt-water sailor. He was graduated in 1932 from the Webb Institute of Naval Architecture, one of the unique schools of engineering in the United States, whose alumni rate fourth in number among the engineers listed in "Who's Who in Engineering" in spite of the fact that its graduating classes seldom exceed ten.

As a well-endowed institution, a Webb education is free to students selected by competitive examination who can meet the high standards.

For two years Mr. Reed worked at the Electric Boat Company, Groton, Conn. During the war he was with the United States Maritime Commission specializing in propeller design and ship vibration. Currently he is a development engineer with Arthur D. Little, Inc., a firm of consulting engineers.

Active in the Congregational and Episcopal Churches, Mr. Reed believes that "learning to get along with our neighbors—here and throughout the world—is far more important than any other problems facing the world today and that the principles of the Christian religion when logically and intelligently thought through and applied with assurance, offer the best basis for handling human affairs."

Mr. Reed is vice-chairman of the Boston Section. He has three children.

Robert L. Reich

Robert L. Reich, who has taken over as editor of the Forum, is director of engineering for the Akeley Camera Company, New York, N. Y. He is a graduate of the Brooklyn Polytechnic Institute, and has had extensive experience in design and development of photoelectric and photorecording equipment. Following World War II he was one of the experts to study and report on the German photography industry. He holds patents on instruments used in medicine, lectures on photographic instruments, and is consulting engineer to three companies on mechanical and production problems.

Mr. Reich is a member of the Instrument Society of America, American Society of Tool Engineers, and the Society of Motion Picture Engineers.

He finds his relaxation in good music as written by Bach and Wagner, his recreation in gardening and administering to a new home, and his joy in his family. His two-year-old daughter almost broke up one of the Committee's meetings recently.

Quote

WHAT the young engineer does outside of his work is of tremendous importance not only for his own good but for the good of the nation as a whole. What he can do and how he can do it will be given much consideration by me during the year."

(James D. Cunningham,
President-Elect ASME)

Notes on Annual Meeting

JUNIOR members of The American Society of Mechanical Engineers who want to get some firsthand information about the broader aspects of their profession will note the following events scheduled for the 1949 ASME Annual Meeting. (See pages 951–957 of this issue for tentative program.)

Tuesday, November 29. 2:30 p.m. This session on education of young engineers will tell them what industry and educators are thinking about postgraduate training in industry. Professional registration and what it means to the young engineer will also be covered. A self-appraisal method designed to help a young man to evaluate his engineering talents will be described.

Tuesday, November 29. 5:15 p.m. Do not miss the Wright Memorial Lecture to be delivered by one of the top men of the American Bar. Chief Justice Vanderbilt is a remarkable man in many respcts. As one of the great men of a sister profession, what he has to say on "Standards for Citizenship" will be important to young engineers.

Tuesday, November 29. 8:15 p.m. A symposium of the junior engineer in 1950 is being sponsored by the National Junior Committee. It will cover the conditions which young engineers may expect in the near future in the way of job opportunities. You will hear about employment and salary trends, new job horizons, opportunities for advancement and professional development, and comment on collective bargaining. Part of the session will be devoted to questions from the floor.

Thursday, December 1. 9:30 a.m. The Railroad Division is sponsoring a symposium on what the railroad industry has to offer young graduates. This is a field which has been overlooked by graduates in recent years. There may be some good talk here.

New ASME Officers Elected by Letter Ballot

AS reported by the tellers of election, 1950, George E. Hagemann, Robert H. McLain, and Paul T. Onderdonk, letter ballots received from members of The American Society of Mechanical Engineers were counted on Sept. 27, 1949. The total number of ballots cast was 8570; of these 112 were thrown out as defective.

	Votes For	*Votes Against*
For President		
James D. Cunningham..	8441	17
For Regional Vice-Presidents—serve 2 years		
Frank M. Gunby.....	8445	13
John C. Reed.....	8440	18
Albert C. Pasini.....	8445	13
Samuel H. Graf.....	8448	10
For Director at Large—serve 4 years		
Thomas E. Purcell.....	8452	6
Benjamin P. Graves....	8451	7

ROY H. SMITH WHO WAS RECENTLY NAMED A FELLOW OF THE ASME

The new officers will be introduced and installed in office during the 1949 Annual Meeting of the Society to be held at the Statler Hotel, New York, N. Y., Nov. 27–Dec. 2, 1949.

Biographical sketches of the newly elected officers were published in the September, 1949, issue of MECHANICAL ENGINEERING, pages 785–788.

Roy Harmon Smith Elected Fellow ASME

ROY H. SMITH, president and general manager, The Lamson and Sessions Company, Cleveland, Ohio, has been elected Fellow ASME. Election to the Fellow Grade is a distinction bestowed on outstanding members of the ASME.

Major Smith was born in Staunton, Va., Feb. 19, 1879, and was educated at Brown University; in 1901 he received an ME degree. He earned the money for his college expenses by working as a part-time designer during the school year.

Graduate of Brown University

In 1901 he was employed by the Russell, Burdsall, and Ward Bolt and Nut Company, Port Chester, N. Y., and later the American Bridge Company, Pencoyd, Pa. In 1904 he was chief draftsman for the Waterbury Farrel Foundry and Machine Company, Waterbury, Conn. He left Waterbury to go to Cleveland, Ohio, to serve as general superintendent of the National Screw and Tack Company. From 1914 to 1921 he was vice-president and treasurer of the Falls Rivet Company, Kent, Ohio; interrupted only during World War I, when he served as major, Ordnance Dept. Then from 1921 to the present he has been associated with The Lamson and Sessions Company where he has served as vice-president and director of operations and is now president and general manager.

He has been actively interested in the affairs of his community and was for two years president of Council, City of Kent, Ohio, and later served for two years as mayor of the city. During his term as mayor he conceived the following projects and was the driving force that helped carry them to completion before the end of his term: design and construction of a combined city hall, jail, and garage; and the design and construction of a plant and equipment for treating city water for purpose of removing iron rust and other impurities.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council, to be approved by Council.

ASME Sections

Coming Meetings

Chicago: November 15. Metals Division Meeting at Western Society of Engineers rooms, 7th floor, 84 E. Randolph St. Speaker: H. W. Browall. Subject: Carbon-Steel Product Qualities; Interpretation and Application.

November 22. Ladies' Night. Dinner Meeting at Furniture Club. Speaker: Dr. Lillian Gilbreth.

Cleveland: November 10. Cleveland Engineering Society Building at 8 p.m. Subject: Experimental Stress Analysis. Speaker to be announced.

Iowa-Illinois Section: November 22. Section meeting. Dinner, followed by an inspection trip to the Davenport Works, The Aluminum Corporation of America. Members' wives and guests are invited to attend.

Metropolitan: November 4. Power, Fuels, Oil and Gas Power Divisions, Room 502,[1] 7:30 p.m. Subject: Gas Turbines, by W. E. P. Johnson.

November 9. Process and Metals Division, Room 501,[1] 7:30 p.m. Fiberglas—An Engineering Material, by Dr. A. W. Davison.

November 17. Photographic Group, Room 502,[1] 7:30 p.m. Surgical Color Movies, by K. M. Smalley and Donald Allen.

November 16. Junior Group, Room 1101,[1] 7:30 p.m. Centrifugal Pumps for High-Pressure and Underground Service, by C. Shurupoff.

November 22. Engineers' Forum, Room 1101,[1] 7:30 p.m. Pensions—Who Should Support Them.

Plainfield: November 16. Elk's Club, Elizabeth, N. J. Dinner at 6:15 p.m. Regular Section meeting at 8:15 p.m. Subject: Heat Pumps. Speaker: F. R. Ellenberger.

Southern California: November 9. Meeting of the Power Division at 7:30 p.m. A meeting of the division will be held in Engineering Building "B," Room 105, of the University of

[1] Engineering Societies Building, New York, N. Y.

Southern California. Speakers: C. N. Hardin, and J. H. Sulwold. Subject: Handling, Storing, and Burning of Fuel Oil.

November 16. Meeting sponsored by Hydraulic and Industrial Engineering Division of the Southern California Section. Subject: Engineering Specifications. Speaker: Anthony Hunter. Time and place to be announced later in *The Engineer*.

November 30. University of Southern California at 8 p.m. Meeting arranged by the Committee on Hydraulic and Pneumatic Systems. Subject: Energy Considerations in Hydraulic Devices. Speaker: Dr. Henry Fuchs, assistant chief engineer, Preco, Inc. (The committee on Hydraulic and Pneumatic Systems is sponsored by the ASME, ASCE, IAS, SAE, and the American Rocket Society.)

Washington, D. C.: November 10. Speaker: H. F. Barr. Subject: The New Cadillac Engine.

Section Activities

REPORTS of the following ASME Section Meetings were received recently at Headquarters:

Birmingham, Sept. 19. Speaker: C. L. Huey. Subject: Steam for Power. Attendance: 48.

Central Indiana, Sept. 10. Family picnic at Forrest Park, Noblesville, Ind. Attendance: 100.

Cleveland, Oct. 13. Fall Get-Together.

Oct. 20. Power-Instrument Discussion Group. Discussion leader: H. H. Gorrie. Subject: Electronic Versus Mechanical Metering.

Oct. 27. Machine-Design Discussion Group. Speaker: P. R. Payson. Subject: Antifriction Bearings.

New Orleans, Sept. 29. Barbecue. Attendance: 48.

Student Branch Activities

REPORTS of the following ASME student branch meetings were received recently at Headquarters:

Brown University, Sept. 29. Organizational meeting. Attendance: 55.

University of California, Sept. 22. Business meeting. Attendance: 207.

Case Institute of Technology, Sept. 27. Organizational meeting. Attendance: 90.

Clarkson College of Technology, Sept. 28. Film: Steam for Power. Attendance: 190.

Clemson A and M College, Sept. 27. Membership meeting. Attendance: 75.

Colorado A and M College, Sept. 28. Business meeting. Attendance: 76.

Cooper Union (Day), Sept. 26. Organizational meeting. Attendance: 20.

Kansas State College, Sept. 22. Membership meeting. Attendance: 144.

Sept. 29. Election of officers. Attendance: 130.

Kansas University, Sept. 28. Election of officers. Attendance: 60.

University of Kentucky, Sept. 22. Business meeting. Attendance: 200.

Michigan State College, Sept. 28. Business meeting. Attendance: 77.

Northeastern University, Sept. 15. Membership meeting. Attendance: 90.

Sept. 22. Election of officers. Attendance: 68.

Notre Dame, Sept. 21. Organizational meeting. Attendance: 85.

Oklahoma A and M College, Sept. 26. Business meeting and entertainment. Attendance: 200.

Princeton, Sept. 29. Election of officers. Attendance: 32.

Rensselaer Polytechnic Institute, Sept. 20. Speaker: Prof. N. P. Bailey. Subject: Fields for Mechanical Engineers and Their Relation to Power Development. Attendance: 175.

Rose Polytechnic Institute, Sept. 22. Film: Sand and Flame. Attendance: 25.

Sept. 22. Organizational meeting. Attendance: 70.

University of South Carolina, Sept. 22. Business meeting. Attendance: 32.

University of Southern California, Sept. 20. Business meeting. Attendance: 61.

Washington State College, Sept. 22. Membership meeting. Attendance: 92.

Yale University, Sept. 27. Business meeting. Attendance: 45.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER, three and a half years' design, layout: tools, dies, automatic machinery. Knowledge production methods. Artistic ability. Desires product design, development, sales promotion. Prefers plastics. Me-533.

MECHANICAL ENGINEER, age 40, Purdue graduate. Ten years' experience with manufacturer of small-precision instruments, in charge of process planning, special tooling, and development of new products. Northwestern Pennsylvania. Me-534.

MECHANICAL ENGINEER, BSME, University of Michigan, 1947, desires position in small growing concern. General experience in physical testing of metals and automotive engine engine-dynamometer testing. Midwest. Me-535.

METALLURGICAL-MECHANICAL ENGINEER: Production or development position requiring knowledge ferrous, nonferrous, or powder metallurgy. MS, ME. Stevens. Metallurgical development and teaching background. New Jersey or New York. Me-536.

MECHANICAL-ENGINEERING GRADUATE, BE, ME, June, 1949. Desires trainee position in power or plant-engineering field. Single, twenty-two, veteran. East, South, or Midwest. Me-537.

MECHANICAL ENGINEER, 30, BME. Experienced in aircraft inspection, maintenance, and structural testing. Three years as air-force officer. Desires position with opportunity for advancement in product-design development or sales. Me-538.

MECHANICAL AND REGISTERED PRODUCTION ENGINEER, 35, single, BSME, graduate, 1938, university gold medalist, extensive executive experience in heavy industry and general engineering, good organizer, proved ability, versatile, reliable, and linguist, widely traveled in foreign countries, good references, and connections, desires position with American manufacturers intending to establish factories in India or Pakistan, resident Bombay. Me-539.

ADMINISTRATIVE ENGINEER, 37, mechanical graduate, 1935. Heavy experience in automatic-machinery development, precision machine tools, and plant engineering, light to heavy metal fabrication. New York Metropolitan area or Midwest. Me-540.

PLANT ENGINEER, 32, ME, married, ten years' experience in plant layout, maintenance, supervision, and process engineering in brass fabrication, and foam-rubber industries. Foreign service considered. Me-541.

[1] All men listed hold some form of ASME membership.

MECHANICAL ENGINEER, MS in ME project engineer in heavy-chemical industry, power, process, design. 25, married, desires responsible position. Me-542.

RECENT MECHANICAL-ENGINEERING GRADUATE, Brown University, desires a start in any field except sales. 23; single; free to travel. Me-543.

MECHANICAL ENGINEER, 37, BSME, 1934. Married. Fifteen years' experience in production and industrial engineering. Inspection, piecework planning, shop supervision in steel construction and sheet-metal field. Development of detail-drawing and material-production analyses and schedules for machinery-drafting division of large industry. Nine years' drawing-room experience. Desires position as assistant production engineer, assistant to chief engineer, or heat-of-material control section of metals-manufacturing firm. Me-544.

MECHANICAL ENGINEER, BS, recent graduate, University of Pennsylvania, 28, married. Desires trainee or junior position in production or maintenance engineering with progressive firm. Ambitious, industrious, and capable. Locate anywhere. Me-545.

MECHANICAL ENGINEER, graduate, four years production foreman manufacturing plant, two years director vocational education, five years college ME professor, and sixteen years' experience building, repairing, valuation, selling and purchasing steam and Diesel locomotives. Me-546.

MECHANICAL ENGINEER, 23, BS, 1949, one year's work in quality-control testing and rate setting. Desires technical heat-power position, power-plant design preferred. Me-547.

MECHANICAL ENGINEER, June, 1949, graduate, Cooper Union, veteran, 23. Upper 10 per cent of class. Good electronics and drafting experience. Will relocate. Me-548.

RECENT GRADUATE, mechanical engineer, University of Pennsylvania, 26, single, with no experience, would like to obtain some experience. No location preference. Me-549.

MECHANICAL ENGINEER, 27, BSME, PG, IE, two years' experience gas-production and power-plant construction administration. Prefers operation or production work in manufacturing field. Presently residing in New York. Will relocate Northeast U. S. Me-550.

DEVELOPMENT ENGINEER OR ADMINISTRATOR, 44, married, registered, Harvard Business School, outstanding experience in process and equipment development, instrument and control-design application sales. Good organizer, inspiring creative efficient team work. Me-551-496-D-68.

PROJECT ENGINEER OR TECHNICAL ASSISTANT EXECUTIVE, 36, BME. Fourteen years' diversified experience covering conception of ideas, design, development, liaison, trouble shooting. Nine years automatic control and servomechanisms; five years industrial-lithographic field. Northeastern U. S. A. Me-552.

MECHANICAL ENGINEER, MSME, methods, development, last ten years' experience analyzing small-parts assembly and improving production methods. Reorganization of individual work places, design of assembly fixtures, reduction of waste and spoilage. 47. Two-hundred-mile radius New York. Me-553.

MECHANICAL ENGINEER, BS, MME, PE. License New York State in November. Four years' heavy experience design, testing, field supervision of industrial power plants, auxiliaries, steam and electric distribution, etc. Me-554.

PLANT ENGINEER, ME, 44, family, wishes responsible management position with chemical-processing or metal-products company. Twenty-one years' experience directing projects, maintenance, and shops. Me-555.

MECHANICAL ENGINEER, 27, BME. Two years' machine-shop experience, made experimental machine; some drafting experience. Desires position in engineering research or development. Will relocate. Me-556.

POSITIONS AVAILABLE

UTILITIES-DESIGN ENGINEER, preferably mechanical graduate, with ten to fifteen years' experience in the utilities and design engineering fields. Will be responsible for all engineering-design work associated with the supply and distribution of steam, electricity, water, gas, and air in food-processing plants. Starting salary, about $7000. Midwest. Y-2815-R-5934-D.

SENIOR INDUSTRIAL ENGINEER, 30–40, IE degree, for consulting firm. Should have diversified engineering background in plant layout, time study, wage incentives, etc. $7200, plus expenses. Headquarters, New York, N. Y. Y-2837.

WORKS MANAGER, 40–50, graduate engineer, for company in the precision-instrument field. Should have thorough training and experience in the most modern and most effective methods and procedures; at least ten years' experience in the manufacture and assembly of small metal parts in a high-precision industry, in operating capacity; at least five years' experience as works manager or assistant works manager of a large company in the precision-instrument field. $15,000–$20,000. East. Y-2842.

ENGINEERS. (*a*) Manufacturing vice-president, graduate mechanical engineer preferred, to take complete charge of all manufacturing operations. Must have at least ten years' experience in industrial engineering and plant management, preferably in metalworking industry. $8000–$10,000, plus percentage of profit. (*b*) Production-control manager, particularly experienced in inventory control and purchasing of screw-machine and metal parts. Should be capable of developing new vendors as company purchases considerable quantities of fabricated metals. Salary to $6500. Northern New Jersey. Y-2844.

MECHANICAL ENGINEER, young, who has had responsible experience in a mill engaged in the manufacture of wire rope or electric cable. Should be capable of assuming complete charge of maintenance, repair, design changes, etc., of all machinery in wire-rope plant. Should have sufficient wire-rope engineering experience to assume responsibility in connection with designing wire ropes and assume responsibility for proper manufacture. Excellent opportunity. Salary open. East. Y-2856.

SALES ENGINEER, 32–37, preferably graduate mechanical, with four to five years' experience calling on industrials and distributors in the East, to sell valves to process and power plants and pipe distributors. $6000, plus bonus. Headquarters, northern New Jersey. Y-2863.

GRADUATE ENGINEER, 35–45, experienced in industrial filtration, i.e., oil, solvents, water. Must be capable of supervising all engineering groups. Duties will be supervision of design, experimental work, and field engineering. Good opportunity. Salary open. Up state New York. Y-2868.

DESIGN ENGINEER, 35–40, with at least ten years' experience in design of filling and bottling machinery, to supervise design department. Must have administrative ability. Products involved are in the beverage and brewery-machinery field. $8000–$10,000. Midwest. Y-2869-C.

ENGINEERS. (*b*) Cost estimator, 35–45, mechanical graduate, with diversified manufacturing experience on electromechanical devices, including considerable estimating experience, to prepare data on production costs. (*c*) Liaison engineer, 35–45, mechanical graduate, to co-ordinate purchasing with production facilities of vendors. Must have considerable experience in surveys of precision-production equipment. Salaries, $5000–$7000. Massachusetts. Y-2876.

STRESS ANALYST, with at least three to five years' experience in this type of work on gas engines or turbines. $5000–$7000. Northern New Jersey. Y-2879.

MECHANICAL AND CHEMICAL ENGINEERS, under 30, with master's degrees for work involving studies and investigations of processing, equipment improvement, plant layout, and cost reduction. Some research and design may be involved at times, but work will be mainly of a development nature. Should be flexible as to location. Delaware. Y-2880.

SENIOR EXECUTIVE, CHIEF MECHANICAL ENGINEER, AND DESIGNER to take charge of engineering department of company manufacturing home-movie equipment. Should have executive ability. Salary open. New York metropolitan area. Y-2881.

ENGINEERS. (*a*) Production-control supervisor, with extensive experience in instrument or precision-equipment field, to take charge of inventory control, scheduling, etc. $5000–$6000. (*b*) Liaison engineer, to co-ordinate estimating and production with contract sales covering punch-press and screw-machine products. $5000–$5500. Connecticut. Y-2883.

MECHANICAL ENGINEER, 35–45, graduate, with industrial power-plant and broad manufacturing experience, including administrative and executive duties, to co-ordinate and supervise power-plant operations, maintenance of production machinery, humidifying equipment, etc., in process-industry manufacturing plant. $15,000. South. Y-2884.

MECHANICAL ENGINEER, 40–45, who has a wide diversified experience in design of various types of machinery, gears, hydraulic hoists, shafting, etc., and who can prove his ability to direct a small development group for a large industry. Salary open. Michigan. D-5227.

PLANT SUPERINTENDENT, experienced in complete plant superintendency in connec-

tion with candymaking or other related processes for a manufacturer. Must have demonstrated competency to handle and satisfactorily conclude labor negotiations for a plant employing a large number of skilled and semi-skilled persons. $12,000. Middle South. R-5925.

DESIGN ENGINEER, about 30, civil or mechanical graduate, with six to eight years' experience with heavy-plate fabrication, heavy-machine shop, and erecting. Knowledge of shopwork and ability to estimate man-hour requirements. Informed about blast-furnace construction. Will assist chief engineers and field and shop work. $3900–$5200. Illinois. R-5930.

PLANT ENGINEER, with ten to fifteen years' general experience, able to take plant measurements, set forth requirements, draft plans, make or secure estimates, inspect construction, supervise tradesmen on construction-plant maintenance and equipment installation: knowledge of stresses and flow data desirable for a distillation process. Salary open. Illinois. R-5937.

ENGINEERS. (*a*) Draftsman-designer, experienced in both machinery and structural design. Willing to work on drafting board for manufacturer of standardized materials-handling machines. Salary open. (*b*) Application engineer, experienced in both machinery and structural design who would work in estimating and sales-engineering department for manufacturer of standardized materials-handling machines. Salary open. Illinois. R-5938.

INDUSTRIAL ENGINEER, under 45, graduate, with minimum of eight years' experience in systems of production control, cost control, incentive wage plans, and manufacturing. Knowledge of methods in the metal-fabrication field. Experienced or informed about punch presses, milling machines, hand and automatic screw machines. Company also has cold reducing mills and continuous slitters, but experience with this equipment not necessary. $6000. Illinois. R-5955.

ENGINEER, mechanical graduate, considerable experience in machine design of metal-spinning equipment, to design and operate metal-spinning department for a manufacturer. Salary open. Illinois. R-5957.

DESIGNER, mechanical graduate, with five or more years' experience in design of hydraulic and pneumatic presses, cylinders, riveters, valves, etc., for a manufacturer in Illinois. About $4200. R-5958.

DEVELOPMENT ENGINEER, young, mechanical graduate, with one or two years' experience with plant-development problems. Creative thinking and knowledge of mechanical motions and effect on product in designing new machines and equipment required. Intricate and high-speed motions, involving processing for a manufacturing process which involves fabrics, chemical engineering, and calendering. $3500–$4500. Illinois. R-5962.

ENGINEERS. (*a*) Mechanical engineer, up to 45, preferably graduate, with ten years' experience, proved record and broad knowledge of machine design, machine processes, stampings, etc., preferably in electromechanical field for a manufacturer of recording equipment. Will ultimately assume executive position. $6000–$8000. (*b*) Process engineer, up to 45, graduate or equivalent, thoroughly experienced in processing on small precision parts, stampings, castings, etc., for manufacturer of recording equipment. $6000. (*c*) Engineer, junior, graduate, at least two to three years in development work in audio field. Will work in laboratory almost independently for manufacturer of recording equipment. $3600. Illinois. R-5965.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Nov. 25, 1949, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ANDERSON, J. S., Salt Lake City, Utah
ARONSON, DAVID, Jeannette, Pa.
BABCOCK, HARRY L., E. Chicago, Ind.
BARCIC, BRIAN, Sharon, Pa.
BARNARD, RUSSELL E., Middletown, Ohio
BARTON, R. REED, York, Pa.
BASS, HERMAN NATHAN, Jackson Heights, N. Y.
BELSER, HOWARD JOSEPH, San Francisco, Calif.
BLACKALL, F. STEELE, 3D, Cumberland Hill, R. I.
BLEYLE, GUSTAVE ADOLPH, JR., Cambridge, Mass.
BROWN, R. C., Sault Ste. Marie, Mich.
BRUCE, BAXTER H., Akron, Ohio
BYER, S., London, England
CARBON, HARRY B., LaPorte, Ind.
CARRELL, JOHN R., Erie, Pa.
COLLEY, DARRELL, Detroit, Mich.
COONEY, THOMAS R., Dayton, Ohio
CORSON, BRUCE, Ann Arbor, Mich.
CRITCHLOW, JOHN P., Mt. Lebanon, Pittsburgh, Pa.
CRUMB, EDGAR A., Washington, D. C.
DALY, JOHN F., Alhambra, Calif.
DANIEL, L. R., Ruston, La.
DELSON, BENJAMIN, Bronx, N. Y.
DONALD, W. L., Chattanooga, Tenn.
DRANSFIELD, CLIFFORD D., Dallas, Texas
EDWARDS, THOMAS P., W. Springfield, Mass.
EHRBAR, JOHN R., Stamford, Conn.
ERDMANN, GLENN CLARENCE, Milwaukee, Wis.
FENSTERMACHER, JOHN B., Alameda, Calif.
FERGUSON, JOHN E., Beaverton, Oreg.
FOWLER, W. A., Greenville, S. C.
FOX, FRED A., Tulsa, Okla.
GERLITZ, GUSTAV A., Minneapolis, Minn.
GOBBO, E., Hoboken, N. J.
GOODMAN, LAWRENCE E., New York, N. Y.
GRAY, CORNELIUS, SR., Los Angeles, Calif.
GREENE, EUGENE G., Westchester, Ill.
GRIST, JOHN W., Kansas City, Mo.
GULATI, J. D., Poona, India.
HAMM, ALBERT L., Middletown, Ohio
HANSBARGER, L. D., Ansonia, Ohio
HANSEN, HARTLEY MARVIN, Chicago, Ill.
HARRIS, EVERETT W., Reno, Nev.
HAUSRATH, ALFRED H., Urbana, Ill.
HEADLEY, FRANCIS LEON, Philadelphia, Pa.
HERBERT, A. M., Piedmont, S. C.
HERBST, HAROLD E., Kansas City, Mo.
HOLLAWAY, RAYMOND LAWSON, SR., Sebring, Ohio
JACKSON, ALBERT J., JR., Trenton, N. J.
JOHNSON, JAMES ROMME, Evanston, Ill.
JOHNSON, RAYMOND G., Richland, Wash.
JONES, MARVIN R., Houston, Texas
KLESNOR, WALTER C., Park Ridge, Ill.
KREIS, JOSEPH D., Cleveland Heights, Ohio
KRILL, ARTHUR M., Denver, Colo.
KUHN, EDMUND W., Cortland, Ohio
LAKRITZ, BERNARD JOSEPH, Bronx, N. Y.
LANG, E. RUSSELL, Long Beach, Calif.
LANG, RICHARD T., Heidenheim, Brz., Germany
LAWSON, S. P., Manchester, England
LINDSTROM, RAYMOND A., Phoenix, Ariz.
LONG, GILBERT E., Lancaster, Pa.
MALANI, B. D., Montreal, Que., Can.
MARTIN, PASCHAL, Chicago, Ill.
MCFALL, CHARLES RALPH, Johnson City, Mo.
MCLAREN, EDWARD W., JR., Troy, N. Y.
MERCADANTE, NICHOLAS J., Brooklyn, N. Y.
MERKEL, HARRY HOWARD, Braintree, Mass.
MILLAR, J. W., North Bay, Ont., Can.
MILLER, HAROLD K., Wyandotte, Mich.
MORTON, ROBERT C., Los Angeles, Calif.
NOLAN, ROBERT W., Newport News, Va.
NOLL, GERALD O., Alhambra, Calif.
OVERLY, ELTON A., Overland Park, Kan.
POTTER, Richard C., Manhattan, Kan.
POWERS, HEMEN, Pittsburgh, Pa.
QUIGLEY, L. D., Trenton, N. J.
RECORDS, W. A., North Bend, Ohio
REEMAN, JAMES, Wembley, England
RIORDAN, FRANCIS, Little Ferry, N. J.
ROBINSON, SAMUEL T., Wyandotte, Mich.
ROLOSON, ALFRED, Worthington, Ohio
SCHNELL, FRANK ALONZO, Johnson City, N. Y.
SILVEN, E. GILBERT, Cranston, R. I.
SLAWINSKI, MILTON V., Long Island City, N. Y.
SMITH, RAYMOND W., Akron, Ohio
SMITH, ROBERT EARL, Allentown, Pa.
SOONG, WILLIAM E., Chicago, Ill.
SPIEKERMANN, WALTER, S. Charleston, W. Va.
STEIN, SAMUEL, Venice, Calif.
STEWART, ROBERT A., Cincinnati, Ohio
STILLMAN, CHARLES, Elizabeth, N. J.
TAYLOR, P. C., Willoughby, Ohio
THURSTON, RICHARD C. A., Ottawa, Ont., Can.
TROUM, HAROLD B., W. New York, N. J.
VERKKOLA, TORSTEN RAFAEL, Milwaukee, Wis.
WACHER, J. T., Trona, Calif.
WALBACK, RALPH D., Tempe, Ariz.
WALLACE, FLOYD C., Kansas City, Mo.

(*ASME News continued on page 980*)

UNIT TANDEM

YARWAY'S Answer to High Pressure Blow-Down Requirements

As pressures increase, so does the demand for dependable blow-off valves to meet these needs.

The Unit Tandem is Yarway's answer . . . proved by hundreds of successful high pressure installations in leading utilities and industrial plants.

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Unit Tandems are built for pressures to 2500 psi.

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YARWAY BLOW-OFF VALVES

WALLACE, WILLIAM HAMILTON, Tempe, Ariz.
WARD, RICHARD J., Norristown, Pa.
WEATHERHOLT, F. D., E. Pittsburgh, Pa.
WEBER, JOHN A., Austin, Texas
WIEGAND, ROBERT E., Portland, Oreg.
WILSON, NATHANIEL S., Baltimore, Md.

CHANGE IN GRADING

Transfers to Member and Associate

ANNIS, RUPERT ELLSWORTH, JR., Waterville, Me.
ANTHONY, W. O., Dixon, Ill.
BICE, RICHARD A., JR., Albuquerque, N. Mex.
BARBER, EDMUND A., JR., Johnson City, N. Y.
BLAINE, DAVID G., Chicago, Ill.
BOYER, VINCENT S., Philadelphia, Pa.
BRIGGS, CHARLES B., JR., Mission, Kan.
BROWN, HUBERT L., N. Kansas City, Mo.
BRUCE, WILLIAM, Montreal, Que., Can.
CARDWELL, FRANKLIN D., Richmond Hill, N. Y.
CARTER, CHARLES W., Thompsonville, Conn.
CHAPIN, B. R., Wichita, Kan.
CLARK, HENRY L., JR., Winchester, Mass.
CONRAD, JOSEPH D., Springfield, Pa.
CRAWFORD, CLARK A., Corning, N. Y.
EDWARDS, ROBERT W., Rochester, N. Y.
FITZGERALD, MICHAEL J., Syracuse, N. Y.
FRAAS, ARTHUR P., Rio de Janeiro, Brazil
FRANKENBERG, THEODORE T., New York, N. Y.
GERDING, JOHN E., Rocky River, Ohio
GROSS, LESTER, St. Louis, Mo.
HARTFORD, ERNEST, New York, N. Y.
HEINEN, FRED C., New York, N. Y.
HEROLD, RICHARD, Far Hills, N. J.
HERTENSTEIN, E. W., JR., Baltimore, Md.
ISHAM, CLARENCE A., Bronx, N. Y.
KELLER, JOHN M., Honolulu, Hawaii
KRAUSE, OTTO C., Louisville, Ky.
KREITLER, FRANK C., JR., Erie, Pa.
KRUPP, JOHN O., Los Angeles, Calif.
LAND, MALCOLM L., Jeannette, Pa.
LAWRENCE, GEORGE E., Rochester, N. Y.
LOU, NILS H., Detroit, Mich.
MARLEY, GEORGE E., Pittsburgh, Pa.
MATER, MILTON H., Corvallis, Oreg.
MAXWELL, ROBERT LOUIS, Knoxville, Tenn.
MCPHETERS, LINWOOD S., Wellsville, N. Y.
MILEY, HARRIE W., Rochester, N. Y.
MURRAY, JULIAN RONALD, Evanston, Ill.
NEWBERG, ERIC G., JR., Newport, R. I.
OOSTEN, LOUIS, Evanston, Ill.
SEELIG, CHARLES B., Pittsburgh, Pa.
SIMON, SAMUEL S., Brooklyn, N. Y.
SIMONS, EUGENE M., Columbus, Ohio
SOLA, SAMUEL L., Los Angeles, Calif.
STAMPFLE, A. B., Bethlehem, Pa.
STEURER, GEORGE E., Dayton, Ohio
TENETY, JAMES, JR., Brooklyn, N. Y.
THOMSON, JOHN B., Manhasset, N. Y.
WATSON, DOUGLAS, Palo Alto, Calif.
WEBER, PAUL R., Charleston, W. Va.
WETTERSTROM, EDWIN, Chicago, Ill.
WHITE, KENNETH H., Troy, N. Y.
WHITE, R. BYRON, JR., Northfield, Vt.
WILLIAMS, RAY S., Orrville, Ohio
YANDRE, THOMAS E., Orlando, Fla.

Transfers from Student Member to Junior 450

Obituaries

Charles James Anderson (1892–1949)

CHARLES JAMES ANDERSON, chief engineer and supervisor of maintenance, Crouse-Irving Hospital, Syracuse, N. Y., died April 22, 1949. Born, Croydon, Pa., Nov. 6, 1892. Education, Merit system course power-plant engineering, N.A.P.E.; Steam-electric course, I.C.S., 1916. Mem. ASME, 1948. Survived by his wife.

Thomas Knox Banks (1881–1948)

THOMAS K. BANKS, engineer, Woodward and Lothrop, Washington, D. C., died of an acute coronary thrombosis in Hyattsville, Md., Dec. 27, 1948. Born, West Hartlepool, England, April 25, 1881. Parents, Thomas and Jane (Knox) Banks. Education, Durhan College of Science; M.I.T.; and Carnegie Institute of Technology. Naturalized, Buffalo, N. Y., 1918. Married Eleanor Cook (deceased, 1916); daughter, Eleanor. Married 2d, Isabel Ennis, 1927. Assoc.-Mem. ASME, 1918; Mem. ASME, 1935. Survived by wife and daughter, Mrs. Eleanor (David) Cook, Burlington, N. C.

Ward Beckwith (1902–1949)

WARD BECKWITH, consultant in management engineering, died at his home in Wellesley Hills, Mass., of a coronary thrombosis, July 17, 1949. Born, Boston, Mass., June 3, 1902. Parents, Edwin A. and Jessie (Cowden) Beckwith. Education, Tufts College, 1920–1923; Pennsylvania State College, 1923–1924. Married Marion Sanford Thompson, 1927. Mem. ASME, 1942. Survived by wife; son, Peter, and two daughters, Paulina and Barbara.

William Scott Bergland (1885–1949)

W. S. BERGLAND, design engineer, engineering department, E. I. du Pont de Nemours and Co., Inc., Wilmington, Del., since 1911, died of a coronary thrombosis at his home in Hockessin, Del., May 7, 1949. Born, Lexington, Ky., Oct. 27, 1885. Parents, Eric and Lucy Scott (McFarland) Bergland. Education, BS, 1908, and EE, 1910, Princeton University. Married Eloise Beale Bond, 1912. Assoc.-Mem. ASME, 1918; Mem. ASME, 1935. Survived by wife and four children, Mrs. David Worcester, Boston, Mass.; Hugh L. B. Bergland, Weldon, Ill.; Lucy Scott Bergland, U. S. State Department, Dublin, Ireland; and Charles B. Bergland, Bristol, Conn.

Henry Walter Berkley (1891–1949)

HENRY W. BERKLEY, retired mechanical engineer, died in San Jose, Calif., on June 1, 1949. Born, Searcy, Ark., Aug. 1, 1891. Education, EE, University of Texas. Mem. ASME, 1929.

Sven Brun Bugge (1878–1949)

SVEN B. BUGGE, president, Tomahawk Kraft Paper Co., Tomahawk, Wis., died after a long illness on Aug. 9, 1949. Born, Larvik, Norway, Jan. 9, 1878. Parents, Sven Brun and Henriette (Corneliussen) Bugge. Education, graduate, Horton (Norway) Technical School, 1898. Married Doris Charnock, 1911. Mem. ASME, 1916.

Frank Wyatt Collins (1883–1949?)

FRANK W. COLLINS, whose death was reported to the Society, was a mechanical engineer, Pan-American Engineering Co., Berkeley, Calif. Born, Dallas, Oreg., April 21, 1883. Mem. ASME, 1921.

William L. Dawe, Jr. (1920–1949)

WILLIAM L. DAWE, JR., vice-president, Dawe Contracting Corp., Baltimore, Md., died July 24, 1949. Born, Brooklyn, N. Y., Oct. 21, 1920. Parents, William L. and Marguerite E. Dawe. Education, The Choate School; BS, Lafayette College, 1944. Married Jean McNeil Boyer, 1943. Jun. ASME, 1945. Survived by wife and two children, William L., 3d, and Linda Dawe.

Thomas Gemmill Estep (1883–1949)

THOMAS G. ESTEP, retired professor of mechanical engineering, Carnegie Institute of Technology, died at his home in Alexandria, Pa., Aug. 7, 1949. Born, Alexandria, Pa., 1883. Parents, Thomas G. and Louise Estep. Education, BS, Pennsylvania State College, 1905. Married Kathryne Beaver, 1910. Member, Pi Tau Sigma; Tau Beta Pi. Author of "Problems in Thermodynamics and Heat-Power Engineering" and the "Mechanical Engineering Laboratory Manual." Mem. ASME, 1919; Fellow ASME, 1949. Survived by his wife and daughter, Mrs. Anna Louise Stewart, Pittsburgh, Pa.; a grandson and a sister, Margaret Estep, Lebanon, Pa.

Charles Noel Flagg, Jr. (1881–1949)

CHARLES N. FLAGG, JR., president, C. N. Flagg and Co., Inc., Meriden, Conn., died May 28, 1949. Born, Paris, France, March 31, 1881. Parents, Charles Noel and Ellen F. (Earle) Flagg. Education, Pratt Institute. Married Julie F. Smith. Mem. ASME, 1915. Survived by wife and son, Peter, Meriden, Conn.

Henry Flood, Jr. (1887–1949?)

HENRY FLOOD, JR., whose death was reported to the Society, was at one time a partner, Murray and Flood, Inc., New York, N. Y. Born, Elmira, N. Y., Feb. 9, 1887. Education, ME, Cornell University, 1909. Assoc.-Mem. ASME, 1916; Mem. ASME, 1935.

Walter Winn Gayle (1890–1949)

WALTER WINN GAYLE, Southern agent and vice-president in charge of sales, Saco-Lowell Shops, Charlotte, N. C., died at his home in Charlotte, March 1, 1949. Born, Montgomery, Ala., March 12, 1890. Parents, William A. and Mary (Winn) Gayle. Education, BSME, University of Alabama, 1911; BS in Textile Engineering, Philadelphia Textile School, 1915. Married Anne Holt, 1916. Mem. ASME, 1946. Survived by wife, son, Walter, Jr.; and daughter, Mrs. Hood McChord, Fort Mill, S. C.

John Francis Guentner, Jr. (1922–1948)

JOHN FRANCIS GUENTNER, JR., mechanical engineer, died at the Veterans Hospital, Aspinwall, Pa., July 15, 1948. Born, Millvale, Pa., May 8, 1922. Parents, John Francis and Hilda (Schell) Guentner. Education, BSME, University of Notre Dame, 1948. Married Mary Elizabeth Patterson, 1947. Jun. ASME, 1948. Survived by wife and parents.

Philip M. Hammett (1867–1949)

PHILIP M. HAMMETT, retired engineer, superintendent, motive power, Maine Central Railroad Co., died in Mandarin, Fla., March 14, 1949. Born, Newport, R. I., Aug. 30, 1867. Parents, Charles E., Jr., and Parthea G. (Jones) Hammett. Education, AB, Harvard University, 1888; ME, M.I.T., 1890. Married Louise Plack, 1893; children, Louis P., Waldo

(*ASME News continued on page 982*)

CENTRIFUGAL

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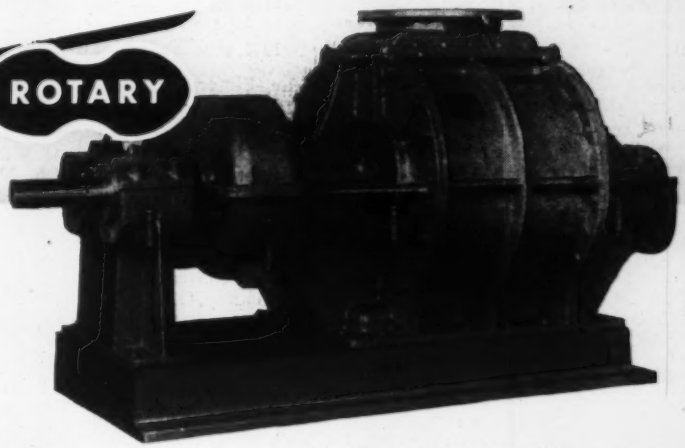

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